OCCUPATIONAL MEDICINE: DISEASE RISK FACTORS AND HEALTH PROMOTION

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OCCUPATIONAL MEDICINE: DISEASE RISK FACTORS AND HEALTH PROMOTION

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EDITORIAL
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Editorial: Occupational Medicine: Disease Risk Factors and Health Promotion

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Keywords: COVID-19, prevention, worker, burden, cancer, injury, exposure, workplace

Editorial on the Research Topic

Occupational Medicine: Disease Risk Factors and Health Promotion

Occupational Medicine has always been concerned with preventing health problems caused by working conditions, and with promoting and maintaining the highest level of physical, mental, and social wellbeing of workers in all occupations (1–3). In the last few decades, with an aging work population and arise in sickness and absenteeism with the associated financial impacts on organizations, workplace health promotion has become a top priority. Regarding this issue, some research groups have carried out studies on health promotion. In a survey, Di Lorenzo et al. compared healthcare workers with other employees on adherence to the Mediterranean Diet and blood lipid profile; their results showed the preventive contribution in the context of periodic health surveillance by occupational physicians. Research group of Garcia-Rojas carried out a non-randomized company-based trial to evaluate a worksite health promotion program in seven Mexican companies. The investigation confirmed that a promotion activity carried out in an occupational medicine context could be helpful to reduce high blood pressure, in particular, among diabetic workers (Garcia-Rojas et al.). Hanson et al. pointed out that it is appropriate to intervene on some groups of workers such as those working in construction and homecare, who seem to have higher modifiable and non-modifiable risk factors compared to the general population. Hermann et al. and Merati et al. reported that it is appropriate to carry out strategies based on occupational medicine to mitigate the risks that may interfere with the overall health of workers. In Italy, a good practice implemented by Tuscany Region on anti-meningococcal vaccination was highlighted among the healthcare workers (Gattini et al.).

The coronavirus disease 2019 (COVID-19) pandemic has also changed the public opinion on the need for safe practices in the workplace and has focused the attention of governments and institutions worldwide on the fundamental role that the occupational safety and health services play. In particular, healthcare workers have been affected by the various waves of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) even with psychological harm (Al-Kuwari et al.; Costantino et al.; Dudine et al.); this has also affected other workers (Haan et al.). The COVID-19 has also impacted the transport and the environment (De Maria et al.).

Naithani et al. found a low baseline knowledge of occupational health hazards and demonstrated that an appropriate form of training can reduce injuries, resulting from occupational hazards and ensure a healthy workforce that can contribute toward a positive impact on national economies.

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Moreover, more attention should be given to the long-term effects of ionizing radiation. The occupational protection of radiographic inspection workers should be strengthened to reduce and/or avoid occupational injuries, thus, protecting the health and safety of workers (Hao et al.). Furthermore, symptoms of low-frequency time-varying magnetic fields were studied by Bravo et al.. The investigation did not show any association between the occurrence of reversible subjective symptoms, including the more specific "core symptoms." On the other hand, the role played by occupational stress appears to be not negligible (Bravo et al.). Psychosocial issues were also addressed. Alabi et al., in a wide-ranging review, analyzed the interventions to improve job satisfaction and job retention among oncologists, and, therefore, to improve patient care. Healthcare professionals are increasingly affected by events that can affect mental health, and, therefore, it is advisable to evaluate various hospital profiles and settings. In fact, Primary Care nurses showed higher levels of work engagement and a lower perception of psychosocial risks than Emergency nurses (García-Iglesias et al.). This finding was also confirmed by Rostami et al. in a cross-sectional study carried out on nurses, midwives, and administrative workers.

Not only are healthcare workers affected by psychosocial disorders, various studies also reported burnout among Private Security Staff (Veljković et al.) and a reduction of psychosocial factors in optimal work conditions among workers subjected to heavy physical work (Sala et al.).

Another issue is balancing work and family demands. Family and job responsibilities may affect many aspects of health, and sleep is an important issue. The reduction of work-family conflict improves sleep quality (Silva-Costa et al.).

In occupational medicine, an emerging problem is the underestimated lack of work that can cause damage to the health of workers. Costa et al. highlighted that females are associated with higher stress levels, pointing out the relevance of specific interventions in the context of health promotion programs, especially in order to mitigate stress in more susceptible subjects.

Finally, workplace interventions on the health, safety, and lifestyle of workers can be a model to export to developing populations. In the last few years, new exposure assessment methods in occupational settings have led to significant improvements in the quality of scientific studies and other measures to promote and support workers' health. On the other hand, several persistent as well as emerging issues (i.e., the increase in chronic disease and mental ill health; work-related stress, technological advances, and new ways of working such as smart working) justify the continuing need for novel strategies to better assess the exposure to old and new occupational risk factors.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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REFERENCES

1. Durand-Moreau Q, Le Deun C, Lodde B, Dewitte J-D. The framework of clinical occupational medicine to provide new insight for workaholism. *Indus Health*. (2018) 56:441–51. doi: 10.2486/indhealth.2018-0021
2. Ramaci T, Pellerone M, Ledda C, Rapisarda V. Health promotion, psychological distress, and disease prevention in the workplace: a cross-sectional study of Italian adults. *Risk Manag Healthc Policy*. 2017;10:167–75. doi: 10.2147/RMHP.S139756
3. Rapisarda V, Cannizzaro E, Barchitta M, Vitale E, Cinà D, Minciullo F, et al. A combined multidisciplinary intervention for health promotion in the workplace: a pilot study. *J Clin Med*. (2021) 10:1512. doi: 10.3390/jcm10071512

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ORIGINAL RESEARCH
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Relationship Between Work Engagement, Psychosocial Risks, and Mental Health Among Spanish Nurses: A Cross-Sectional Study

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Background: Exposure to risk factors may lead to health problems of varied nature and to an increased risk of suffering accidents at work.

Objectives: The aim of this study was to evaluate the work engagement, psychosocial risks, and psychological well-being of Spanish nurses, analyzing existing relationships, and their associations with self-reported mental health problems of nurses.

Methods: To this end, a cross-sectional observational study was carried out with a sample of 1,704 Spanish nurses between January 2019 and January 2020, using a self-administered questionnaire containing sociodemographic variables, the Spanish version of the Copenhagen Psychosocial Questionnaire (CoPsoQ-istas21), the Utrecht Work Engagement Scale (UWES-9), and the General Health Questionnaire (GHQ-12).

Results: The Kruskal-Wallis test showed that nurses' perceptions for each of the tests significantly differed among different healthcare areas ($p < 0.05$). The results indicated that emergency nurses offered higher scores in all dimensions of the CoPsoQ-istas21 and GHQ-12 tests; and in primary care, nurses scored higher in all three dimensions of the UWES-9 test. In addition, self-perceived health and vigor at work were identified as predictive factors of mental health.

Conclusions: A high percentage of Spanish nurses perceived a high level of psychosocial risk in the exercise of their duties and nearly 41% could suffer from some mental health-related problem. Primary Care nurses showed higher levels of work engagement and lower perception of psychosocial risks than Emergency nurses. Results may allow to identify a professional profile which is more likely to suffer from psychological distress, as both the working conditions and the work commitment expressed by nurses in their daily work are key elements in assessing the possible psychosocial risks to which they may be exposed.

Keywords: health personnel, mental health, work engagement, occupational disease, nurses, primary health care, emergency medical services

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INTRODUCTION

The health sector is considered to be one of the most exposed to occupational risks (1). The health worker may have his health compromised by frequent, continuous, and persistent exposure to physical, chemical, biological, ergonomic, and psychosocial risks of various kinds and nature (2). These idiosyncratic working conditions related, for example, to intensive and rotating work shifts, high levels of stress and high psychological demands, among others, may affect the development of psychological disorders, as is the case of nursing professionals (3).

In this context, perspectives are required to refocus understanding and intervention in the psychosocial context and its interaction with the person, focusing on premises that value the positive capital of people and the organizational context in which they develop occupationally and personally. Relevance should focus not only on the risk factors that can have negative consequences, but on the protective factors that can facilitate the prevention of such risks, leading to subjective welfare states by the healthcare professional (4). Within this perspective, importance has been given to the study of engagement as a shield against burnout, that has its own entity (5). Engagement is understood as an emotional, cognitive, and psychological construct that refers to a positive and satisfactory mental state related to work, based on three dimensions: vigor (high energy levels and mental endurance), dedication (work involvement, enthusiasm, and challenge by work), and absorption (total concentration at work) (6).

In this sense, having committed employees increases productivity levels, results in greater enthusiasm and interaction with colleagues, more motivation and creativity, and a decrease in absenteeism levels and the number of errors (5). To do this, it is necessary for personal factors such as situational factors to encourage increased levels of engagement.

In recent decades, from this approach of positive psychology, special emphasis has been placed on the relationship between health, well-being, and happiness, being sufficiently and scientifically proven at this point that the evidence of these variables in the person brings about consequences that are considered desirable, at the very least, and in the working context (7, 8).

According to the results of the 6th European Working Conditions Survey (9), nurses, due to their working conditions, present a clear and remarkable increase in reporting mental health problems and psychological discomfort (7, 8), which mainly manifest in irritability, stomach pain, sleep problems, and anxiety-like symptoms (9). In this sense, physical health is also affected, and a greater number of symptoms are observed, as compared to the rest of the working population.

Nurses experience recurrent symptomatology related to unfavorable psychosocial conditions as a result of their work performance: high levels of stress, anxiety, emotional overload, or fatigue, mainly as a result of the nature of their work and the place where they perform their work (10, 11). These adverse psychosocial circumstances are also related to reduced quality of life in their self-perceived health levels and also regarding well-being (5). Similarly, there is an increase in absenteeism and the number of cardiovascular, musculoskeletal, and mental health-related diseases. These effects, according to the Job Demands-Resources Model by Bakker et al. (12) may be explained by the imbalance between resources and demands, where work demands are more numerous than work and/or personal resources.

Adverse working conditions affecting the health of nurses have been identified in very different work environments. Primary care (PC) nurses are subjected to a shortage of time to perform their duties and this fact may be related to their patient quota, excessive bureaucratic tasks (11), being subjected to geographical dispersion by having to assist outside their health centre and, in many cases, having to treat a population with a high level of dependence and complexity (13). In the case of intensive care units (ICU) and hospital emergency services (HES), nurses may be exposed to stressful situations due to the critical situation of the patient, and especially in HES (14, 15), where unpredictable events must be dealt with and being this the service where nurses are most exposed to aggression (16). As has been observed in nurses working in emergency and out-of-hospital emergency services (OHES), a high presence of symptomatology related to work stress (physical and emotional fatigue, overload, tension, and anxiety) has been observed that may pose a risk of impaired mental health to nurses working in these environments (17, 18).

As a result of this evidence, over the last few years, concern for the occupational health of the nursing professional collective has led to the development of studies related to pathologies and traits linked to professional performance (19). The data obtained show the need to address this problem that causes suffering and professional and personal impairment, and which directly affects the quality of the care provided (5).

As mentioned, there is evidence that the variability of the work environment of the nursing profession conditions the risk factors to which professionals are exposed. This study raises the hypothesis that the profile of the work environment influences the psychosocial risk endured by nurses and its effect on their mental well-being. It would be interesting to compare the psychosocial impact of different clinical settings to identify professionals at greatest risk and design preventive interventions adapted to each reality. The objective of this study was to describe the work engagement, psychosocial risks, and psychological well-being of a sample of Spanish nurses belonging to different areas of care, analyzing the relationships between these variables and their associations with self-reported mental health problems of nurses.

MATERIALS AND METHODS

Study Design and Participants

A cross-sectional study was conducted on a population of 185,835 Spanish nurses. According to the National Institute of Health Management (*INGESA*, for its acronym in Spanish) (20) under the Ministry of Health, in 2018 there were 185,835 nurses working in the National Health System, of which 30,499 worked in PC, 150,269 in specialized care (8,101 were part of the HES), 3,061 in the OHES and 15,716 nurses worked in the private health sector (of which 1,754 worked in private HES).

For this population, a necessary sample of 386 nurses was estimated for a 5% error, with a 95% confidence and a heterogeneity of 50%. As inclusion criteria, the following were established: (i) nurses who carry out healthcare, teaching, management and/or research work typical of their profession; (ii) resident in the national territory (Spain); (iii) active nurses; and (iv) who have accepted the informed consent. The exclusion criteria were: (i) not performing strictly nursing tasks; (ii) Spanish nurses working outside Spain at present.

An accidental or causal sampling method was followed, obtaining a sample of 1,808 participants. Of the total, those questionnaires that were not fully completed or had inconsistencies were eliminated, so 5.75% of them were removed from the study (losses), leaving a final sample of 1,704 participants.

Finally, participants were classified in three groups according to where they performed their duties: A group of PC nurses, a group of EC nurses (emergency care nurses of HES-OHES), and a group that included the rest of nurses. These were the arranged groups, as they are considered the most heterogeneous in terms of functions, stress levels, types of shifts and working hours, severity of the patient to assist, and professional profile (13, 21–23).

Instruments

The questionnaire distinguishes four parts: (1) sociodemographic variables; (2) psychosocial risk assessment; (3) engagement assessment; and (4) psychological well-being assessment and detection of non-psychotic psychiatric problems.

Basic sociodemographic information included sex, age, place of residence, type of entity where they worked, type of position they occupied, type of service, time working at the current centre, type of employment contract, working hours (type of work, working days per week, out-of-hour tasks, shift changes), financial benefit they received, absences from work (work leave), and substance use.

The Spanish version of the Copenhagen Psychosocial Questionnaire (CoPsoQ-istas21) (24) was used for the assessment of psychosocial risks. CoPsoQ-istas21 is an evaluation tool aimed at assessing psychosocial risks, identifying and locating such risks and facilitating the design and implementation of preventive measures. This instrument consists of 5 dimensions that are: Psychological Requirements, Active Work and Skills Development, Social Support in the Company, Compensation, and Double Presence. In relation to reliability, it has an internal consistency with a high Cronbach alpha ($\alpha = 0.92$). The simple summation of the total points made it possible to determine the score for each dimension. This score calculated the number of workers at low, medium, or high-risk levels. Low (L), medium (M), and high (H) levels had different scores depending on the dimension: Psychological demands (L: 0–8; M: 9–11; H: 12–20), Active work and skills development (L: 0–5; M: 6–8; H: 9–20), Social support in the company (L: 0–3; M: 4–6: H: 7–20); Compensation (L: 0–2; M: 3–5; H: 6–12), and Double Presence (L: 0–1; M: 2–3; H: 4–8).

The Utrecht Work Engagement Scale (UWES) (25) was the instrument used to assess engagement at work and it consists of nine items distributed in three items for each dimension (vigor, dedication, and absorption), with a Likert scale of seven points which ranges from "never or not once" to "always or every day." Cronbach's alpha reliability indexes are as follows: vigor ($\alpha = 0.82$), dedication ($\alpha = 0.86$), and absorption ($\alpha = 0.8$).

The UWES survey gave three partial mean scores, corresponding to each subscale, and a total score within the range of 0–6 points. In addition, percentages of the score were compared according to the following recoding: 1 (Sometimes per year) from 0 to 0.99; 2 (Once or less per month) from 1 to 1.99; 3 (Sometimes per month) from 2 to 2.99; 4 (Once a week) from 3 to 3.99; 5 (Sometimes per week) from 4 to 4.99; and 6 (Every day) from 5 to 6.

The General Health Questionnaire (GHQ-12) (26) is a self-administered screening test that evaluates psychological well-being and detects non-psychotic psychiatric problems. It consists of 12 items: 6 positive and 6 negative sentences. GHQ-12 has proven good reliability in the different studies carried out, with Cronbach alphas ranging from 0.76 to 0.86 in the Spanish population (27).

Responses are valued on a Likert scale from 0 to 3 points. Scores 0 and 1 were recoded as 0, and scores 2 and 3, as 1. The total score was calculated by adding the scores obtained in all items of the dichotomous scale and 3 was considered a breakpoint for this one-dimensional screening instrument, with a range between 0 and 12 points. The percentage of individuals considered to present high values in terms of impaired mental health was determined, based on the number of individuals with higher atypical scores.

Procedure

Data were collected through an online questionnaire conducted by three psychologists and two nurses. The questionnaire was distributed by the General Council of Nursing and the Nursing Colleges of each Spanish province through a web link to Google Forms©, being disseminated through their official webpages and social networks. Likewise, the link was shared in social networks via WhatsApp, Twitter, and LinkedIn.

Data collection took place between January 2019 and January 2020.

Statistical Analysis

Descriptive statistics were presented as percentages and frequencies. The Kolmogorov-Smirnov test was used to determine whether the data exhibited normal behavior. The Kruskal-Wallis test was used to check for differences in the analyzed groups with respect to the assessment of the different dimensions, and the Mann–Whitney *U*-test with Bonferroni correction was used to analyse which subgroups differed from each other.

The bivariate analysis between the variables under study and having or not psychological distress shows the value of statistical significance with Chi-squared, the estimated risks from the Odds Ratios (OR), and their confidence intervals. Finally, in order to predict the probability that a healthcare professional has to present distress, a logistic regression analysis was carried out based on those factors that, after the preliminary analytical study, were considered most influential (sex, age, service in which

the professional works, perceived general health, UWES vigor, UWES dedication, UWES absorption, and total UWES).

Previous analysis of the data suggested that the working group could have a confounding effect on the variables to be included in the model. In order to identify this effect, statistical significance was assessed by chi-squared, as well as risks and confidence intervals of the stratified analysis by differentiating the data as they belonged to PC, HES-OHES, or other areas with those variables with the greatest risk, obtaining significant differences in all cases. The contrast of OR values by strata led to the conclusion that, in all independent variables under study, there were significant differences between the groups ($p < 0.001$). Therefore, to avoid confusion in the model, it was chosen to determine the most optimal model in each working group, avoiding excessive interactions within the same model.

SPSS version 20.0 software was used for the study.

Ethical Considerations

Participants voluntarily responded to the questionnaire and accepted the informed consent. The questionnaire explained in detail the study subject matter and included the participant's consent. Participants' responses were recorded anonymously, and the information was treated confidentially.

The study was conducted under the "Ethical Principles for Medical Research Involving Humans" contained in the latest version of the Helsinki Declaration (Fortress Amendment, Brazil, October 2013). It was also approved by the Ethics Committee of the General Council of Nursing (Spain) in April 2018.

The data obtained during the study were processed in accordance with Organic Law 3/2018 of December 5 on the Protection of Personal Data and guarantee of digital rights.

RESULTS

Sample Characteristics

Of the 1,704 participants who provided analysable data (loss of 5.75% compared to 1,808), 18.1% of them (308) were PC nurses, 8.7% (149) were EC nurses, and 73.2% (1,247) belonged to the other areas. The mean age of the people surveyed was 41.69 years (standard deviation 10.79), with 86.3% of them being females.

Most participants worked in a public or associated hospital (59.91%, 1,020), 18.08% in a health centre (308), and the rest in other institutions (22.01%, 375). 49.01% (801) of participants had remained in their current workplace for more than 10 years. They were civil servants 27.73% (484), permanent (indefinite contract) 28.99% (484), interim 21.03% (358), and temporary 19.44% (360). The rest of contractual relationships (discontinuous-permanent, temporary with training contract, etc.) accumulate < 1.5% of the cases each. 92.47% (1,567) of the surveyed nurses have a full-time contract, with a reduction in working hours in 9.89% of these cases. Similarly, they perform tasks that they consider to correspond to their professional category 70.64% (1,188), while 20.54% (362) think their work is above their category, and the rest, below (3.67%; 73) or do not know (5.05%; 81). The most common working hours include working both weekdays and weekends and holidays in 54.97% (968) of cases, or from Monday to Friday in 31.47% (525) of cases. The mean distance from the place of residence to the work centre was 16.68 km (standard deviation 25). 24.08% (441) of the participants earn a net amount per month ≤ 1,500 euros; ∼50% (47.52%, 838) receive between 1,501 and 2,100 euros; 17.2% (263) receive up to 2,400 euros, 11.21% (162) receive more.

Test Assessment

The number of cases, percentages, mean scores, and deviations typical of the three analyzed tests (CoPsoQ-istas21, UWES, and GHQ) for each dimension are shown in **Table 1**, both globally and by type of service.

Mann–Whitney *U*-test for independent samples with Bonferroni correction showed that perceptions of nurses significantly differed depending on the service. The statistics and *p*-values associated with this test were listed in **Table 2**.

Work Engagement Level

More than 75% of PC nurses achieved a mean percentage of 5 or 6 in all subscales and in the total score. For EC nurses, the percentages associated with means of 5 or 6 were 57.72% regarding vigor, 71.14% for dedication, and 62.42% in absorption. However, for the group in the rest of the areas, the percentages were 58.46, 69.61, and 69.81%, respectively, and in both services, this percentage of the total was slightly higher than 62%. Specifically, in all areas under study, more than 30% reported experiencing these feelings every day, as compared to less than a mean value just over 2% who does sometimes per year (**Supplementary Material 1**).

Psychosocial Risk Assessment

Most study participants had a high psychosocial risk, as more than 50% of them perceive a high level of risk (red color), except in the Compensation dimension, in which they showed a medium-high level (**Figure 1**).

Psychological Well-Being Assessment

The assessment of the GHQ test stands out for a central positioning of the values, as well as the asymmetry on the right in all cases. 41.14% (701) of professionals scored with values > 3 in the GHQ test. This percentage was lower for PC nurses (30.52%, 94), slightly higher for EC nurses (47.65%, 71), and very similar in other areas (42.98%, 536) (**Supplementary Material 2**).

Binary Logistic Regression

The logistic regression analysis was performed on the basis of factors that were considered most influential after the preliminary study. These independent variables were: sex, age, working group (PC, EC, or other areas), perceived general health, score in vigor, dedication, absorption scales, and total in the engagement questionnaire (UWES).

Bivariate analysis, between study variables and having or not distress, shows the Chi-squared value of statistical significance, estimated risks from Odds Ratio (OR), and their confidence intervals (**Table 3**).

All the bivariate contrasts made were significant, which indicated the relationship between the variables, positive in the case of OR values greater than the unit. It is worth noting that health professionals with a mediocre or poor perception of health

TABLE 1 | Descriptive results of the three variables: psychosocial risks (CoPsoQ-istas21), work engagement (UWES), and psychological well-being (GHQ).

		PC nurses	EC nurses	Other areas	Overall total	Independent sampling Kruskal-Wallis test	
	Number of cases	308	149	1,247	1,704		
	Percentage no of cases	18.08%	8.74%	73.18%	100%		
		Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	χ^2	*p*
CoPsoQ-istas21	Psychological Requirements (0–20)	11.97 (2.80)	13.96 (2.75)	13.54 (2.82)	13.29 (2.88)	82.460	0.000
	Active Work and Skills Development (0–20)	7.75 (3.22)	9.47 (3.05)	8.65 (3.16)	8.56 (3.19)	33.261	0.000
	Social Support for the Company (0–20)	7.60 (3.37)	9.03 (3.20)	8.44 (3.19)	8.34 (3.24)	24.004	0.000
	Compensation (0–12)	4.60 (2.77)	5.50 (2.64)	5.29 (2.82)	5.19 (2.81)	19.832	0.000
	Double Presence (0–8)	3.37 (1.64)	3.81 (1.74)	3.52 (1.68)	3.52 (1.68)	7.464	0.024
UWES	Vigor (0–6)	4.44 (1.29)	4.00 (1.35)	3.98 (1.36)	4.06 (1.36)	34.029	0.000
	Dedication (0–6)	4.70 (1.32)	4.39 (1.49)	4.31 (1.45)	4.39 (1.44)	21.777	0.000
	Absorption (0–6)	4.63 (1.28)	4.07 (1.56)	4.21 (1.42)	4.27 (1.42)	21.150	0.000
	UWES_Total (0–6)	4.59 (1.21)	4.15 (1.38)	4.17 (1.30)	4.24 (1.30)	31.886	0.000
GHQ	General Health Questionnaire	2.94 (3.41)	4.17 (3.79)	3.87 (3.70)	3.73 (3.67)	19.778	0.000

PC, Primary Care; EC, Emergency Care; SD, Standard deviation.

TABLE 2 | Comparison between psychosocial risks (CoPsoQ-istas21), work engagement (UWES), and psychological well-being (GHQ) according to the type of nursing service.

Mann–Whitney *U*-test for two independent samples		PC nurses *vs*. EC nurses		PC nurses *vs*. Other areas		EC nurses *vs*. Other areas	
Test	**Dimension**	**Statistical**	***p***	**Statistical**	***p***	**Statistical**	***p***
CoPsoQ-istas21	Psychological Requirements (0–20)	14006.00**	0.000	252658.00**	0.000	85641.00	0.116
	Active Work and Skills Development (0–20)	15871.50**	0.000	223618.00**	0.000	79275.50*	0.003
	Social Support for the Company (0–20)	17170.50**	0.000	221095.00**	0.000	83682.50*	0.046
	Compensation (0–12)	18253.50**	0.000	221130.50**	0.000	88538.50	0.345
	Double Presence (0–8)	19425.50*	0.007	203391.50	0.101	84151.50	0.055
UWES-9	Vigor (0–6)	27469.00**	0.001	151159.50**	0.000	91903.00	0.829
	Dedication (0–6)	25636.50*	0.040	159217.50**	0.000	88572.50	0.350
	Absorption (0–6)	27744.00**	0.000	156665.00**	0.000	96429.00	0.446
	UWES_Total (0–6)	27297.50**	0.001	152308.00**	0.000	92034.00	0.852
GHQ-12	General Health Questionnaire –Likert scale	18307.00**	0.000	219137.50**	0.000	88031.50	0.294
	General Health Questionnaire –Dichotomous scale	18290.00**	0.000	220838.50**	0.000	88174.00	0.305

*$p < 0.05$, ** $p < 0.001$.
PC, Primary Care; EC, Emergency Care.

had a 3.935 ([2.943; 5.262]) higher risk of suffering distress than professionals with an optimal perception of overall health.

Prior to the construction of the models, a new bivariate analysis was performed between the variables under study and whether or not having distress, in each of the three working groups. **Table 4** lists the significant variables in each of the binary regression models, the estimated risks from the Odd Ratios (OR), and confidence intervals for these models. In the three models, PC nurses, EC nurses, and those from other areas, the perceived health and subscale variables of the UWES test were predictive. Age was significant in the groups of PC and of other nursing areas, while sex and the dedication subscale of the UWES test were only significant in the last group. The absorption subscale and the total scale of the UWES test were not significant in any of the three models, so they were not shown in the table. The Hosmer and Lemeshow test showed no statistical significance (lp $>$ 0.005 in all three models), which indicated a good fit in the logistic regression model. On the other hand, the omnibus test made it possible to state that the variables included in the model, taken together, help explain the modifications that occur in the likelihood of having psychological distress ($p < 0.001$).

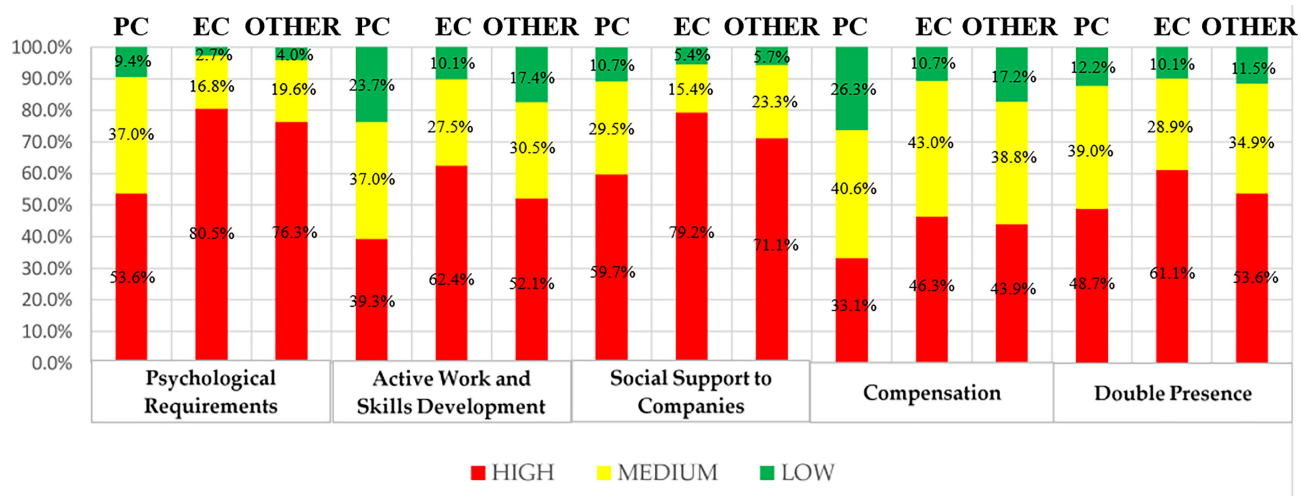

FIGURE 1 | Risk levels by dimension and service (CoPsoQ-istas21).

In the proposed model for PC nurses, predictive capacity was 18.6%, correctly classifying 75.1% of professionals, with a sensitivity (proportion of professionals without distress correctly classified) of 90.5%, and a specificity (proportion of professionals without distress correctly classified) of 40.40%. PC nurses with a mediocre or poor perception of health had 4,448 (95% CI = [2.134; 9.273]) times higher risk of psychological distress than those professionals with an optimal health perception. For those where vigor is not present at least once a week, the risk was 3.052 (95% CI = [2.308; 7.121]) times higher and it was also higher in professionals 41 years of age or younger (OR = 1.924; 95% CI = [1.092; 3.390]).

In the model presented for EC nurses, the modalities that had the highest weight were having a mediocre or poor perception of health (OR = 3.040; 95% CI = [1.080; 8.546]) and vigor less than once a week (OR = 3.625; 95% CI = [1.520; 8.641]). The model correctly ranks 66.4% of EC nurses, with a sensitivity of 82.9% and a specificity of 48.6%, being 14.5% the predictive capacity.

Finally, focusing on the rest of the areas, being female (OR = 1.682; 95% CI = [1.157; 2.444]), 41 years of age or younger (OR = 1.612; 95% CI = [1.257; 2.067]), having a mediocre or poor perception of health (OR = 3.382; 95% CI = [2.340; 4.890]), and vigor and dedication less than once a week (2.561; 95% CI = [1.786; 3.673]) are the modalities with the highest risk of psychological distress. The model correctly ranks 68.2% of professionals, with a sensitivity of 84.2%, a specificity of 47.2%, and a predictive capacity of 17.4%.

DISCUSSION

This study found, in a sample of 1,704 Spanish nurses, how psychological risks, level of engagement, or psychological well-being presented significant differences between the different types of services, i.e., emergency services, primary care, and other areas. The results indicated that emergency nurses showed high levels of psychological risk and psychological distress, and in primary care, nurses scored higher in all three dimensions of work engagement. In addition, self-perceived health and vigor at work were identified as predictive factors of mental health.

With regard to the assessment of psychosocial risks, obtained through the CoPsoQ-istas21 questionnaire, in four of the five dimensions (Psychological Requirements, Active Work and Skills Development, Social Support for companies, and Double Presence), a high-level prevalence predominates in the three groups under study, ranging from 80.5 to 48.7%. With regard to the Compensation dimension, case percentages are higher at high levels for the groups of EC nurses and of other areas, with a predominantly intermediate level among PC nurses (40.6%). This is consistent with previous studies (14) such as that conducted on 42 Resident Internal Physicians of the San Cecilio University Hospital (Granada, Spain), where 90% of doctors perceived a high risk in the Psychological Requirements dimension, low levels for the Social Support to Companies dimension, and an intermediate risk perception for 78% of the sample, as happened in the study by González-Cabrera et al. (28) on emergency practicians in Granada (Spain). In a larger sample (29), consisting of 844 health team workers from 23 public hospitals in Cordoba, Argentina, unfavorable assessments predominated in the Psychological Requirements (57.7%), Social Support and Leadership Quality (56.2%), and Double Presence (64%) dimensions, so data from both studies are in line with those found in the present one. It should be noted in the latter study (29) the variability between the different professionals since, in the compensation dimension, high risk was more common among nurses, unlike medical staff, where the Psychological Requirements ($p < 0.001$) and Social Support and Leadership Quality dimension presented a higher frequency at the level of risk, as compared to other professionals. Social support may be a key element to minimize the negative consequences of stress, as this may be one of the most important emerging risks regarding occupational health and management (30). It is particularly

TABLE 3 | Bivariate analysis between study variables and having or not psychological distress*.

	TOTAL	GHQ≤3	GHQ>3	χ^2 (*p*)	OR (95% CI)
	N (%)	N (%)	N (%)		
Total	1,704 (100)	1,003 (58.86)	701 (41.14)		
Sex					
0. Male	234	158 (67.5)	76 (32.5)		
1. Female	1,470	845 (57.5)	625 (42.5)	8.401 (0.004)	1.538 (1.148, 2.060)
Age**					
0. Older than 41	833	541 (64.9)	292 (35.1)	26.723 (< 0.001)	1.676 (1.377, 2.040)
1. 41 or younger	840	441 (52.5)	399 (47.5)		
Service group					
0. PC Nurses	308 (8.7)	214 (69.5)	94 (30.5)		
1. EC Nurses	149 (18.1)	78 (52.3)	71 (47.7)	12.776 (< 0.001)	2.072 (1.385, 3.100)
2. Other areas	1,247 (73.2)	711 (57.0)	536 (43.0)	15.921 (< 0.001)	1.716 (1.314, 2.242)
General Perceived Health					
0. Optimal	1,457	927 (63.6)	530 (36.4)		
1. Mediocre or poor	247	76 (30.08)	171 (69.2)	94.146 (< 0.001)	3.935 (2.943, 5.262)
UWES Vigor					
0. At least once a week	1,373	903 (65.8)	470 (34.2)		
1. Less than once a week	331	100 (30.2)	231 (69.8)	139.251 (< 0.001)	4.428 (3.423, 5.755)
UWES Dedication					
0. At least once a week	1,447	925 (63.9)	522 (36.1)		
1. Less than once a week	257	78 (30.4)	179 (69.6)	101.599 (< 0.001)	4.067 (3.053, 5.417)
UWES Absorption					
0. At least once a week	1,439	908 (63.1)	531 (36.9)		
1. Less than once a week	265	95 (35.8)	170 (64.2)	68.628 (< 0.001)	3.060 (2.328, 4.020)
UWES Total					
0. At least once a week	1,398	904 (64.7)	494 (35.3)		
1. Less than once a week	306	99 (32.4)	207 (67.6)	108.237 (< 0.001)	3.826 (2.940, 4.979)

*Numbering before the modalities of each variable indicates the encoding method used for the analysis, coinciding value "0" with the baseline or reference category, and values "1" or "2" with categories that the researcher considers risky; **total cases per variable do not correspond to the total number of professionals because data was not collected for some professionals; OR, Odds Ratio; 95% CI, Confidence Interval level at the 95%; PC, Primary Care; EC, Emergency Care; OR, Odds Ratio; χ^2, Chi-squared.*

striking among EC nurses that the Double Presence dimension is the fourth with the highest percentage of risk, unlike other studies (3, 29), although regarding percentages, both results are in line with percentages close to 60–65%. In contrast, the PC nurses group had a lower percentage of high risk than those from other services, and the mean risk perception was lower than 50% in all dimensions.

Engagement levels were high in a considerable number of healthcare professionals under study, exceeding mean scores above 4 out of 6 in all three dimensions. More than 30% of respondents claimed to have experienced feelings of engagement every day, as compared to < 2% who reported these feelings once a year or less. The total results showed similarities with some previous studies on nurses working in Spanish public hospitals (31), and very close to the work engagement levels found by Schaufeli and Bakker (32) in 2004 in their study on Belgian and Dutch professionals of different fields, with a mean total score of 4.3. In a study on 980 nurses from eight hospitals in Saudi Arabia (20), despite having a total UWES score of 4.1, it was observed that, in the dedication sub-dimension, a score had been obtained fairly higher than in the other two (dedication: 4.6; absorption: 3.9; vigor: 4), being observed in the studies by Aboshaiqah et al. (21), Othman et al. (33), and Wan et al. (34), and in the present study sample. People who feel dedicated to their work have a strong emotional and work involvement with their work, considering difficulties as personal challenges that can be encountered in their day-to-day work. This phenomenon could be explained by the long history that women have had in this profession, assuming the role of caregiver (21). Internationally, it has been observed, in a study (35) conducted in the city of Sao José do Rio Preto (São Paulo, Brazil) on 75 PC nurses, that vigor levels were slightly above the dedication levels, 5.2 vs. 5.3, respectively. At the national level, something similar happens with the study (31) carried out in the northeast of Spain on a sample of 373 nurses from the hospital field, where higher mean scores were observed for the vigor subscale 4.68 (SD = 1.07) than dedication 4.61 (SD = 1.37) and absorption scores 4.34 (SD = 1.24). The literature notes that levels of commitment (in their different dimensions) are influenced by sex, work service, educational level, and type of occupation (31, 34). As other authors indicate, the type of service appears to influence the three dimensions of the UWES scale. It has been observed how more

TABLE 4 | Binary logistic regression model for psychological distress by specialty.

Variables		PC Nurses OR (95% CI)	EC Nurses OR (95% CI)	Other areas OR (95% CI)
Sex (ref. Male)		NA	NA	1.682* (1.157, 2.444)
Age (ref. Older than 41)		1.924* (1.092, 3.390)	NA	1.612** (1.257, 2.067)
Perceived Health (ref. Optimal)		4.448** (2.134, 9.273)	3.040* (1.080, 8.546)	3.382** (2.340, 4.890)
UWES (ref. At least once a week)	Vigor-UWES	3.052* (1.308, 7.121)	3.625* (1.520, 8.641)	2.561** (1.786, 3.673)
	Dedication-UWES	NA	NA	2.031** (1.354, 3.047)
Sensitivity/Specificity		90.5%/40.4%	82.9%/48.6%	84.2%/47.2%
Correctly classified percentage		75.1%	66.4%	68.2%
R^2		0.186	0.145	0.174
Hosmer-Lemoshov test		$\chi^2 = 0.630$ ($p = 0.730$)	$\chi^2 = 1.837$ ($p = 0.399$)	$\chi^2 = 4.342$ ($p = 0.501$)
Omnibus test		$\chi^2 = 43.135$ ($p < 0.001$)	$\chi^2 = 16.744$ ($p < 0.001$)	$\chi^2 = 169.485$ ($p < 0.001$)

*$p < 0.05$, ** $p < 0.001$. NA, variables that are not present in the model; OR, Odds Ratio; 95% CI, Confidence Interval at the 95% level.
PC, Primary Care; EC, Emergency Care; CI, Confidence Interval; OR, Odds Ratio; χ2, Chi-squared.

than 75% of PC nurses scored high across all subscales and in the total score. Regarding the EC nurses and the group that includes the rest of professionals, these percentages are below those found in the PC group. This was the case in the study by Medeiros-Maio et al. (36), on Portuguese PC nurses who carried out their care work in Las Azores (Portugal), and in the studies by Loureno et al. (37) and da Silva et al. (35) on PC healthcare professionals in the state of São Paulo (Brazil). While true, it is striking that a considerable number of healthcare professionals scored high in the Engagement dimension, while few reported feelings of engagement, as was the case in the study by Aboshaiqah et al. (21). It is noted that, especially age (21), the characteristics of the work itself, and the environment can be predictors of work engagement (34, 35).

According to data from the present study, it is observed that four out of ten health professionals may have their mental health impaired (GHQ > 3). These figures are above those found in other studies carried out among healthcare professionals in Spain. For example, in the study by Portero et al. (38) conducted on 235 HES practicians and nurses from four Andalusian hospitals (southern Spain), 32.3% of professionals were found to have impaired mental health. Likewise, in another study carried out in a tertiary hospital in Madrid (central Spain), the differences are even more pronounced (39). In the present study, means of 3.73 (SD = 3.67) are found for the total sample in the GHQ-12, and it is striking that similar scores (3.96 [SD = 3.27]) were found in a study conducted on Japanese nurses following an earthquake in Japan in 2017 (40), unlike other studies such as that conducted by Sánchez-López et al. (41), which compares mental health between female and male nurses obtaining mean scores of 2.28 (SD = 2.81) and 1.61 (SD = 2.45), respectively. As in the general Spanish population, women refer to some mental health problems more often than men, 14.1 vs. 7.2%, figures below those found in the present study (42). This fact shows that Spanish nurses may have an increased risk of mental health problems, as compared to the general Spanish population (39). In addition, there are variables that can increase this risk such as being a woman, young (31), having a mediocre or poor perception of health, having low work commitment (34), and working in services with a high level of stress, as is the case of emergency services. By services, there have been differences of more than one point in the GHQ-12 among nurses working in PC = 2.94 (SD = 3.41), as compared to those working in emergency services 4.17 (SD = 3.79). This could be seen in the study by Abbaspour et al. (43), where 39.7% of health professionals working as OHES in Iran had high levels of risk for mental health impairment. This phenomenon can be explained by the care overload to which EC nurses are exposed. In fact, in the study by Kowalczuk et al. (44) excessive workload proved to increase fatigue symptoms and the probability of more recurrent absenteeism.

With regard to the three predictive models proposed, it is observed that the perceived health and vigor subscale variables of the UWES test are predictive, as was the case in other studies (45), and authors pay particular attention to how nurses with a mediocre or poor perception of their health have 4.448 (95% CI = [2.134; 9.273]) times higher risk of psychological distress in the case of PC nurses than those professionals with an optimal perception of health.

Likewise, as in previous studies (46), it is striking how nurses who feel vigor, dedication and absorption less than once a week have 4.428, 4.067, and 3.060, respectively, more risk of presenting distress than healthcare professionals who manifest such variables at least once a week when they have already been working for a while, as is the case. But these same authors agree

that, in the short term, high levels of work engagement can negatively affect the health of nurses (46).

Among the limitations that the study may pose are those derived from the methodology used itself. First, there could be a possible selection bias in the study population, as it is subjected to the degree of interest of professionals in participating, in addition to the use of self-administered questionnaires. Researchers should rely on the veracity of the data proposed by the people who have participated in the study. In addition, the type of sampling used, being non-probabilistic, allows to have an orientation of the results but not a representativeness of the sample. In this sense, it should be noted that the results point to associations, but do not allow to establish cause-and-effect relationships as it is a cross-sectional study. Finally, although the objective of the study focuses on nurses, it may be interesting to include other professionals in this environment, including non-health workers, in future research.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the General Council of Nursing. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JG-I, JG-S, MO-M, and YN-A: conceptualization, formal analysis, and investigation. JG-I, MO-M, and YN-A: data curation, resources, and writing—original draft. JG-I, JG-S, and YN-A: methodology and writing—review and editing. JG-I and JG-S: project administration. MO-M: software. JG-S and YN-A: supervision. JG-S and MO-M: validation. JG-I, JG-S, and MO-M: visualization. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2020.627472/full#supplementary-material

REFERENCES

1. Orozco-Vásquez MM, Zuluaga-Ramírez YC, Pulido-Bello G. Psychosocial risk factors that affect nursing professionals. *Rev. Colomb. Enferm.* (2019) 18:e006. doi: 10.18270/rce.v18i1.2308
2. Organização Pan-Americana da Saúde no Brasil. *Doenças Relacionadas ao Trabalho: Manual de Procedimentos Para os Serviços de Saúde*. Brasília: Ministério da Saúde do Brasil (2001).
3. Ceballos-Vásquez P, Rolo-González G, Hérnandez-Fernaud E, Díaz-Cabrera D, Paravic-Klijn T, Burgos-Moreno M. Psychosocial factors and mental work load: a reality perceived by nurses in intensive care units. *Rev Lat Am Enfermagem.* (2015) 23:315–22. doi: 10.1590/0104-1169.0044.2557
4. Pérez-Fuentes MC, Molero-Jurado MM, Gázquez-Linares JJ, Simón-Márquez MM. Analysis of burnout predictors in nursing: risk and protective psychological factors. *Eur J Psychol Appl.* (2019) 11:33–40. doi: 10.5093/ejpalc2018a13
5. García-Lourenção L. Work engagement among participants of residency and professional development programs in nursing. *Rev Bras Enferm.* (2018) 71(Suppl. 4):1487–92. doi: 10.1590/0034-7167-2017-0278
6. Salanova M, Llorens S. Current state of research on burnout and future challenges. *Papeles Psicól.* (2008) 29:59–67.
7. Perreira TA, Innis J, Berta W. Work motivation in health care: a scoping literature review. *Int J Evid Based Healthc.* (2016) 14:175–82. doi: 10.1097/XEB.0000000000000093
8. Dempsey C, Assi MJ. The impact of nurse engagement on quality safety and the experience of care: what nurse leaders should know? *Nurs Adm. Q.* (2018) 42:278–83. doi: 10.1097/NAQ.0000000000000305
9. Gomez-Baya D, Lucia-Casademunt AM. A self-determination theory approach to health and well-being in the workplace: results from the sixth European working conditions survey in Spain. *J Appl Soc Psychol.* (2018) 48:269–83. doi: 10.1111/jasp.12511
10. Gómez-Salgado J, Navarro-Abal Y, López-López MJ, Romero-Martín M, Climent-Rodríguez JA. Engagement passion and meaning of work as modulating variables in nursing: a theoretical analysis. *Int J Environ Res Public Health.* (2019) 16:108. doi: 10.3390/ijerph16010108
11. Gómez-Urquiza JL, Monsalve-Reyes CS, San Luis-Costas C, Fernández-Castillo R, Aguayo-Estremera R, Cañadas-de la Fuente GA. Risk factors and burnout levels in primary care nurses: a systematic review. *Aten Primaria.* (2017) 49:77–85. doi: 10.1016/j.aprim.2016.05.004
12. Bakker AB, Hakanen JJ, Demerouti E, Xanthopoulou D. Job resources boost work engagement particularly when job demands are high. *J Educ Psychol.* (2007) 99:274–84. doi: 10.1037/0022-0663.99.2.274
13. Cortés-Rubio JA, Martín-Fernández J, Morente-Páez M, Caboblanco-Muñoz M, Garijo-Cobo J, Rodríguez-Balo A. Working atmosphere in primary care: what needs improving? *Aten Primaria.* (2003) 32:288–95. doi: 10.1016/S0212-6567(03)79277-4
14. Fernández-Prada M, González-Cabrera J, Iribar-Ibabe C, Peinado JM. Riesgos psicosociales y estrés como predictores del burnout en médicos internos residentes en el Servicio de Urgencias. *Gac Med Mex.* (2017) 153:450–8. doi: 10.24875/GMM.17002395
15. Parul S, Anuradha D, Sanjeev D, Arvind S, Kajal S, Rahul B. Occupational stress among staff nurses: controlling the risk to health. *Indian J Occup Environ Med.* (2014) 18:52–6. doi: 10.4103/0019-5278.146890
16. Edward KL, Ousey K, Warelow P, Lui S. Nursing and aggression in the workplace: a systematic review. *Br J Nurs.* (2014) 23:653–4. doi: 10.12968/bjon.2014.23.12.653
17. Miret C, Martínez-Larrea A. The professional in emergency care: aggressiveness and burnout. *An Sist Sanit Navar.* (2010) 33(Suppl. 1):193–201.
18. Barroeta-Urquiza J, Boada-Bravo N. *Libro Blanco: Los Servicios de Emergencia Y Urgencias Médicas Extrahospitalarias en España*. MENSOR Available online at: http://www.epes.es/wp-content/uploads/Los_SEM_en_Espana.pdf (accessed October 1, 2020).
19. Kowalczuk K, Krajewska-Kułak E, Sobolewski M. Factors determining work arduousness levels among nurses: using the example of surgical medical treatment and emergency wards. *Biomed Res Int.* (2019) 2019:6303474. doi: 10.1155/2019/6303474
20. Instituto Nacional de Gestión Sanitaria. *Número de Profesionales de la Enfermería que Trabajan en el Sistema Nacional de Salud (SNS) en los Equipos de Atención Primaria en los Hospitales en los Servicios de Urgencias y Emergencias (112/061) y Especialistas en Formación Según Comunidad Autónoma*. Ministerio de Sanidad. Available online at: https://www.mscbs.gob.es/estadEstudios/sanidadDatos/tablas/tabla14.htm (accessed October 1, 2020).

21. Aboshaiqah AE, Hamadi HY, Salem OA, Zakari NM. The work engagement of nurses in multiple hospital sectors in Saudi Arabia: a comparative study. *J Nurs Manag.* (2016) 24:540–8. doi: 10.1111/jonm.12356
22. Cañadas-De la Fuente GM, Albendín-García L, Inmaculada de la Fuente E, San Luis C, Gómez-Urquiza JL, Cañadas GR. Burnout in nursing professionals performing overtime workdays in emergency and critical care departments. Spain. *Rev Esp Salud Publica.* (2016) 90:e40015.
23. Herrera-Amaya G, Manrique-Abril F. Nursing job satisfaction. Differences of areas in primary health care and intensive care. *Duazary.* (2019) 16:74–86. doi: 10.21676/2389783X.2943
24. Moncada S, Llorens C, Navarro A, Kristensen TS. ISTAS21: the Spanish version of the Copenhagen psychosocial questionnaire (COPSOQ). *Arch Prev Riesgos Labor.* (2005) 8:18–29.
25. De Bruin GP, Henn CM. Dimensionality of the 9-item Utrecht work engagement scale (UWES-9). *Psychol Rep.* (2013) 112:788–99. doi: 10.2466/01.03.PR0.112.3.788-799
26. Goldberg DP, Gater R, Sartorius N, Ustun TB, Piccinelli M, Gureje O, et al. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychol Med.* (1997) 27:191–7. doi: 10.1017/S0033291796004242
27. Rocha KB, Pérez K, Rodríguez-Sanz M, Borrell C, Obiols JE. Propiedades psicométricas y valores normativos del General Health Questionnaire (GHQ-12) en población general española. *Int J Clin Health Psychol.* (2011) 11:125–39.
28. González-Cabrera J, Fernández-Prada M, Molina-Ruano R, Blázquez A, Guillén-Solvas J, Peinado JM. Riesgo psicosocial en el trabajo estrés autopercibido y cortisol en saliva en una muestra de urgenciólogos de Granada. *Emergencias.* (2012) 24:101–6.
29. Acevedo GE, Sánchez J, Farías MA, Fernández AR. Psychosocial risks in the health team public hospitals in the province of Córdoba Argentina. *Cienc Trab.* (2013) 15:140–7. doi: 10.4067/S0718-24492013000300006
30. Lecca LI, Finstad GL, Traversini V, Lulli LG, Gualco B, Taddei G. The role of job support as a target for the management of work-related stress: the state of art. Quality—access to success. *J Manag Syst*. (2020) 21:152–8. doi: 10.3389/fpsyt.2020.591957
31. González-Gancedo J, Fernández-Martínez E, Rodríguez-Borrego MA. Relationships among general health job satisfaction work engagement and job features in nurses working in a public hospital: a cross-sectional study. *J Clin Nurs.* (2019) 28:1273–88. doi: 10.1111/jocn.14740
32. Schaufeli W, Bakker A. *UWES: Utrecht Work Engagement Scale. Manual preliminar (Versión 1.1)*. Utrecht University: Utrecht Países Bajos (2004). Available online at: https://www.wilmarschaufeli.nl/publications/Schaufeli/Test%20Manuals/Test_manual_UWES_Espanol.pdf (accessed October 1, 2020).
33. Othman N, Nasurdin AM. Work engagement of Malaysian nurses: exploring the impact of hope and resilience. *Int J Soc Hum Sci Eng.* (2011) 5:37–42. doi: 10.5281/zenodo.1334395
34. Wan Q, Zhou W, Li Z, Shang S, Yu F. Work engagement and its predictors in registered nurses: a cross-sectional design. *Nurs Health Sci.* (2018) 20:415–21. doi: 10.1111/nhs.12424
35. Da Silva AG, Cabrera EMS, Gazetta CE, Sodré PC, Castro JR, Cordioli-Junior JR, et al. Engagement in primary health care nurses: a cross-sectional study in a Brazilian city. *Public Health Nurs.* (2020) 37:169–77. doi: 10.1111/phn.12694
36. Medeiros-Maio T, Borges E, Abreu M. *Bullying e Engagement em Enfermeiros*. Doctoral Thesis. ESEP: Escola Superior de Enfermagem do Porto, Porto, Portugal (2016). Available online at: http://hdl.handle.net/10400.26/17531
37. Lourenção LG, Silva AG, Borges MA. Levels of engagement in primary health care professionals: a comparative study in two Brazilian municipalities. *Esc Anna Nery*. (2019) 23:e20190005. doi: 10.1590/2177-9465-ean-2019-0005
38. Portero S, Cebrino J, Herruzo J, Vaquero M. Factors related to the probability of suffering mental health problems in emergency care professionals. *Rev Lat Am Enfermagem.* (2019) 27:e3144. doi: 10.1590/1518-8345.3079-3144
39. Sanchez-Lopez P, Saavedra-San Roman AI, Dresch V, Garcia-Quintans L, Rodrigo-Holgado I. Women are more at risk of poor mental health: mental health of spanish nurses measured by the GHQ-12. *Women Health Bull.* (2016) 3:e29603. doi: 10.17795/whb-29603
40. Nukui H, Murakami M, Midorikawa S, Suenaga M, Rokkaku Y, Yabe H, et al. Mental health and related factors of hospital nurses. *Asia Pac J Public Health.* (2017) 29(Suppl. 2):161S–70S. doi: 10.1177/1010539516682589
41. Sánchez-López MD., Dresch V. The 12-Item General Health Questionnaire (GHQ-12): reliability external validity and factor structure in the Spanish population. *Psicothema.* (2008) 20:839–43.
42. Ministerio de Sanidad Consumo y Bienestar Social. *Encuesta Nacional de Salud 2017. ENSE (2017) Metodología. Ministerio de Sanidad Consumo y Bienestar Social Madrid España*. (2017). Available online at: https://www.ine.es/metodologia/t15/t153041917.pdf (accessed October 1, 2020).
43. Abbaspour S, Tajik R, Atif K, Eshghi H, Teimori G, Ghodrati-Torbati A, et al. Prevalence and correlates of mental health status among pre-hospital healthcare staff. *Clin Pract Epidemiol Ment Health.* (2020) 16:17–23. doi: 10.2174/1745017902016010017
44. Kowalczuk K, Krajewska-Kułak E, Sobolewski M. Working excessively and burnout among nurses in the context of sick leaves. *Front Psychol.* (2020) 11:285. doi: 10.3389/fpsyg.2020.00285
45. Tomietto M, Paro E, Sartori R, Maricchio R, Clarizia L, De Lucia P, et al. Work engagement and perceived work ability: an evidence-based model to enhance nurses' well-being. *J Adv Nurs.* (2019) 75:1933–42. doi: 10.1111/jan.13981
46. Shimazu A, Schaufeli WB, Kubota K, Watanabe K, Kawakami N. Is too much work engagement detrimental? Linear or curvilinear effects on mental health and job performance. *PLoS ONE.* (2018) 13:e0208684. doi: 10.1371/journal.pone.0208684

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A Comparison of Safety, Health, and Well-Being Risk Factors Across Five Occupational Samples

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Objective: The aim of this study was to present safety, health and well-being profiles of workers within five occupations: call center work ($N = 139$), corrections ($N = 85$), construction ($N = 348$), homecare ($N = 149$), and parks and recreation ($N = 178$).

Methods: Baseline data from the Data Repository of Oregon's Healthy Workforce Center were used. Measures were compared with clinical healthcare guidelines and national norms.

Results: The prevalence of health and safety risks for adults was as follows: overweight (83.2%), high blood pressure (16.4%), injury causing lost work (9.9%), and reported pain (47.0%). Young workers were least likely to report adequate sleep (46.6%). Construction workers reported the highest rate of smoking (20.7%). All of the adult workers reported significantly lower general health than the general population.

Conclusion: The number of workers experiencing poor safety, health and well-being outcomes suggest the need for improved working conditions.

Keywords: health promotion, health behaviors, occupational safety, health, well-being

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INTRODUCTION

There is growing awareness in the literature that providing a healthy labor force requires integrated consideration of each workplace's impact on employees' safety, health, and well-being (1). This relationship between work and well-being is further impacted by changing trends within the American workforce as well as the nature of work. For example, there is a growing number of working older adults. It is estimated that by 2024, the employment rate of workers 65–74 years is projected to grow by 55% and that of workers 75 years and older is expected to grow by 86% (2). Further, while physically hazardous jobs with high risk of injury and illness continue to exist, jobs that increase the risk of chronic illness are becoming increasingly prevalent as employees remain inactive for long hours, experience high job stress and burnout, and face greater job insecurity and occupational health disparities.

Moreover, the prevalence of preventable chronic health conditions across all age groups is increasing (3). About 60% of the U.S. population suffers from at least one chronic health condition

(4), and healthcare costs associated with these conditions account for 75% of healthcare spending (5). Modifiable exposures and health risk factors such as stress, physical inactivity, and obesity account for ∼26% of employer healthcare costs, at $761 per employee (6).

Occupational injuries in the U.S. workforce continue to be a concern, with 3.2 cases per 100 full-time workers in the private sector and 5.0 per 100 in the public sector in 2014 (7). Furthermore, there are bi-directional interactions of safety and health. For example, workers with obesity who experience workplace injuries experience 80.0% greater working time loss and incur 81.4% higher costs than workers without obesity (8). Another example can be found among commercial truck drivers, where drivers with untreated sleep apnea have a five-fold risk of a serious crash (9). A holistic intervention approach that targets workplace safety, health, and worker well-being can curtail costs from largely preventable workplace injuries and chronic illnesses.

To this end, in 2011, the National Institute for Occupational Safety and Health (NIOSH) launched *Total Worker Health*® (TWH), an approach that recognizes that work is a key determinant of one's health and well-being. This approach prioritizes a hazard-free work environment and emphasizes integrated interventions that collectively target worker safety, health, and well-being. TWH is defined as policies, programs, and practices that integrate protection from work-related safety/health hazards with promotion of injury and illness prevention efforts to advance worker well-being (10, 11). As part of this effort, NIOSH funded the Total Worker Health Centers of Excellence (12), one of which is the Oregon Healthy Workforce Center (OHWC) (13).

An integrated effort first requires monitoring of the safety, health, and well-being risk factors at employee and organizational levels; doing so will help us identify targets for change. At OHWC, we have created a repository of data collected via a set of common measures used across multiple projects, with the goal of comparing safety and health data of participants from various industry sectors. This fairly novel approach has the potential to improve the quality and utility of occupational health research by facilitating stronger comparisons across populations.

Common Measures Approach vs. Meta-Analyses

Occupational health meta-analyses have helped identify relationships between workplace risk factors and employee health outcomes, including correlations between job strain and leisure-time physical inactivity (14), and work stress and tobacco smoking (15). Although such meta-analyses can be powerful, measuring the same construct using different survey items on different scales of measurement, can add error to the conclusions. Meta-analyses can overcome differences in measurement tools by using effect sizes that serve as a standardized measure. Although this approach works well when examining the relationship between different variables, it cannot be applied when comparing single-risk factors across different occupational groups. Using the same measure across studies is a way to increase the precision of the measurement by reducing variability due to the way the survey items are measured.

A common measures approach has multiple advantages. We can utilize the same measures across different study populations to benchmark comparisons of the data. Further, given that there are 19,256 unique industry sectors in the U.S. workforce (16), standardizing the safety and health measures across sectors within occupational safety and health intervention studies allows us to test the effectiveness of program components within and between populations. In turn, this will expedite the process of translating and disseminating interventions to diverse work settings (17). The goal to increase standardization in measurement is consistent with NIH's funding to develop and promote PROMIS®, a set of standard measures that assess physical, social, and mental health among adults and children (18).

Comparing Common Outcomes Across Studies vs. Population-Based Studies

Most studies examining health risks have focused on a specific occupational setting or have used random sampling to estimate the overall population risk (19–23). Although both of these methods make important contributions to understanding the relationship between work and health, both methods leave some gaps. For example, general population studies typically include working and non-working individuals. Further, information about occupations may be limited to broad categories such as white-collar vs. blue-collar occupations (22). All of the population-based studies we found were conducted among working populations outside of the United States, often in European countries where governments sponsor recurring studies on working conditions (15, 20, 21, 24). Generalizations to the U.S. are limited due to possible differences in national policies, work experiences, organizational culture, population health status, and occupational health risk factors. Moreover, large population studies are costly and are conducted only periodically. For example, the European Working Conditions Surveys are collected every 5 years and focus on work-related exposures, not on the impact of work on individual health behaviors (21).

A common measures approach has unique strengths and weaknesses. It can be a powerful research strategy to surveil the safety and health of the workforce, make comparisons between occupations, and inform intervention strategies that are best suited within and across workplace settings. A challenge of the common measures approach is that it can involve a high degree of coordination and buy-in from separate collaborators. However, the advantage is the ability to use individual data on the same scale of measurement to make direct comparisons. This approach may be less expensive and resource-intensive than larger population-based studies. The advantage of a less expensive approach is that it can be done more frequently or fill in the gaps between costly population-based occupational groups. These "grass roots" efforts can be especially helpful in continuously monitor the safety and health of workers as the nature of the work continues to evolve with changes in

technology, shifts in economic policies, and other changing factors in the landscape of work.

We found one other study that uses this common measures approach: Community Interventions for Health (CIH)—a collaboration that seeks to understand the impact of health behavior interventions on health outcomes in developing countries (25). Each country agrees to use a core set of measures designed in a way that adds culturally relevant examples and appropriate items. This approach enables CIH to assemble large datasets from multiple countries and highlight the relationships that are common across different countries (26–28).

The OHWC Common Measures Data Repository currently includes data from five separate studies, and we have compared the safety, health, and well-being outcomes of working populations across different occupations. OHWC presents collective and unique profiles of these worker groups: call center workers, corrections officers, construction workers, homecare workers, and parks and recreation workers. Each work setting includes unique hazards and risk factors, and physical and psychological demands (29). For example, homecare workers often receive little safety training or health benefits, work primarily alone, and are responsible for lifting and moving their consumer-employers multiple times per day (30–32). Construction workers also face considerable physical demands, but have a great deal more supervision and adhere to rigid schedules, making them particularly susceptible to issues regarding work-family conflicts and psychological stress (33).

METHODS

Measures

Baseline data were gathered from five studies funded by NIOSH. A standardized set of measures was agreed upon prior to data collection for each study. From this set, individual study teams selected the measures that best fit their needs. Thus, not every sample reported data on every variable. For purposes of our study, we chose measures of safety (injuries), health [pain, body mass index (BMI), blood pressure], health behaviors (smoking, sleep, exercise), and well-being (health status) used by at least three of our studies. Where possible we computed these variables so that they could be compared with clinical healthcare recommendations or national norms. Additionally, biomarker assessment was conducted by a trained research assistant unless otherwise indicated.

Injuries

Injuries were measured with a single item: "In the last 6-months, if you had 1 or more injuries at work that required you to miss work on following shifts, how many total work days did you miss?" Responses were coded 0 (No missed days) or 1 (Yes, 1 or more missed days). The 6-month timeframe was chosen because research indicates that participant recollection of medical events are less accurate for 1-year than for 1-month (34) however, injuries are rare and thus 1-month was not ideal. Given this 6-months seemed a reasonable compromise between exposure and accuracy.

Pain

Musculoskeletal pain that interfered with normal activities was measured with four items adapted from the Standardized Nordic Questionnaires for the Analysis of Musculoskeletal Symptoms (35). The items asked how often in the last 3 months pain interfered with normal activities at work or at home. The following body areas were included: neck/shoulder, lower back, wrist or forearm, and lower extremities. For the present study, participants were coded as 0 if they answered "not at all" to all questions and 1 if they reported any interference with work on any of the four items.

Health Status

Health status was measured using the SF12v2, which contains 12 survey items measuring eight subscales: general health, physical functioning, role physical, role emotional (i.e., ability to perform role-related responsibilities due to emotional or physical health issues) bodily pain, mental health, vitality, and social functioning. The scale has been validated for use in general U.S. populations, in 10 other countries, and in populations of individuals with a variety of health conditions. Extensive information about the reliability and validity of the SF12v2 can be found in the SF12v2 instruction manual (36). Scores were normed using means and standard deviations from a representative sample of the general U.S. population described in the Participants section of the present paper. Per instructions in the manual, z-scores were computed by subtracting the provided mean for each subscale from the general U.S. sample and dividing by the provided standard deviation for the subscale from the general U.S. sample. Following the instructions in the manual t-score transformations were computed by adding 50 and multiplying by 10. This facilitated a comparison to that national representative sample with a mean of 50 and a standard deviation of 10.

BMI

BMI and cut-offs for overweight and obesity were calculated based on CDC guidelines (37). Participants were weighed with clothes on, pockets emptied, and no shoes, belts or heavy jewelry/watches, etc. For adults, BMI was calculated using the standard formula: weight (kg)/height $(m)^2$. For workers under 18y, BMI was computed based on sex-specific age growth charts. For both groups, individuals were coded as overweight if they had a BMI of 25.0–29.9 and obese if they had a BMI of 30.0 or greater.

Blood Pressure

Blood pressure was taken after 3 min rest followed by 3 measurements, each 1 min apart; then we took the average of those three measurements. Blood pressure cut-offs for pre-hypertension and hypertension were based on NIH National Heart, Lung, and Blood Institute (NHLBI) recommendations (38). Cases were coded as pre-hypertensive if they had a systolic blood pressure of 120–139 mm Hg or a diastolic blood pressure of 80–89 mm Hg, and as hypertensive if they had a systolic blood pressure of $\geq$140 or a diastolic blood pressure of $\geq$90 mm Hg. We did not inquire as to whether workers were participating in anti-hypertensive treatment at the time of data collection.

Smoking

Participants were asked: "In the past 7 days, have you smoked any cigarettes?" Responses were coded 0 (no) or 1 (yes). This is consistent with the U.S. Department of Health and Human Services' initiative to end the tobacco epidemic (39).

Sleep

Sleep was measured using two items from the Pittsburgh Sleep Quality Index (40) to compute time spent in bed. Minimum guidelines for sleep were adopted from the CDC (41). Adults were coded as meeting the minimum guidelines if they got at least 7 h of sleep; young workers were coded as meeting the minimum guideline if they got at least 9 h of sleep per night.

Exercise

For all of the adult participants, exercise was coded as "yes" if the participant reported engaging in moderate or vigorous exercise for 30 min on 5 or more days per week [per CDC recommendations (42)] and "no" if they did not. In the young worker sample, participants were not asked about intensity ("moderate/vigorous").

Participants

Call Center Workers

Participants included 139 employees from two customer service call centers. There are ∼29,000 customer service employees in Oregon (43). Employees were recruited by study advertisements and completed all study activities during work hours. Participants received a $25 gift card for completing the study. Data were collected in the summer through fall of 2015. All study procedures were approved by Oregon Health & Science University (OHSU) IRB #0753.

Correction Officers

Participants in the first study included 85 corrections officers from four Oregon Department of Corrections institutions. Oregon employs ∼2,300 correction officers in 14 state prisons (44). Prior to recruiting participants, permission was granted by the Superintendent of each institution. Participants were full-time security staff at the institutions. Data were collected between June 2011 through May 2013. All study procedures were reviewed and approved by OHSU IRB #7925.

Construction Workers

Participants in the second study included 349 construction workers from two public works agencies with a total of 520 construction workers, giving us a response rate of 67.12%. There are ∼80,000 construction workers in Oregon (43). The results from the main study are published in the article cited here (45). Data were collected on company time in the summer of 2012. Participants were provided a $25 gift card for their participation. All study procedures were reviewed and approved by Portland State University IRB #111884.

Homecare Workers

Participants in the third study included 148 Oregon homecare workers recruited from the population of caregivers enrolled in a publicly funded home care system overseen by the Oregon Home Care Commission (31). There were ∼12,000 homecare workers registered with the OHCC in the spring of 2013 when we collected these data (46). Within this system, caregivers work as independent contractors and are hired directly by "consumer-employers" who qualify for Medicaid-funded in-home services. With the assistance of the Service Employees International Union SEIU and the Commission, workers were recruited in-person at training classes, but also through emails, mailed fliers, and referrals. All study procedures were reviewed and approved by OHSU IRB #5473. The results of the main study are published in the article cited here (31).

Parks and Recreation Workers

In the summer of 2013, we sent emails to 436 young workers (14–24 years of age) from a city parks and recreation department who were seasonal summer employees. Throughout the results and discussion we refer to this sample of 14–24 year olds as young workers and our other samples of workers aged 25 and older as adult workers. Of those invited to participate 178 completed baseline surveys, a response rate of 40.83%. Results from the main study are published in the article referenced here (47). There are about 1,800 parks and recreation workers in the state of Oregon (43). Participants were recruited during new hire orientation; parental consent letters were distributed to minors. No biomarkers were assessed in this study. All study materials and procedures were approved by OHSU IRB #0753.

U.S. General Population Norming Means and SD

The means and SD for norming the scores for comparison to the U.S. general population are in the SF12v2 scoring manual (36). These data are from the 1998 National Survey of Functional Health Status (NSFHS), conducted from October to December 1998 by the National Research Corporation (NRC). Surveys were mailed to randomly selected members of the National Family Opinion (NFO) panel; 7,069 participants responded (overall response rate: 67.8%). The population contained both working and non-working adults. Sampling weights were applied to adjust the sample to match the age, gender, and age-by-gender distribution of the 1998 census.

Analyses

Descriptive statistics, frequencies, means, and standard deviations were computed to create profiles for these participating workers. One-sample *t*-tests were used to test whether the normed scores from our participants on the SF-12 subscales were statistically different from a nationally representative sample, with a mean of 50 for all subscales. Alpha was set at $p = 0.05$ for a two-tailed test for determining statistical significance.

RESULTS

Demographics and Work Characteristics

A comparison of the demographics and work characteristics of the five samples in **Table 1**.

TABLE 1 | OHWC descriptive statistics, demographics, and work characteristics.

	Call center workers		Corrections officers		Construction workers		Homecare workers		Parks and recreation workers	
	N	**M ± SD**	***N***	**M ± SD**	***N***	**M ± SD**	***N***	**M ± SD**	***N***	**M ± SD**
Age	139	38.26 ± 10.47	83	42.66 ± 10.05	347	44.48 ± 9.56	148	51.70 ± 13.19	178	17.98 ± 2.24
Hours/week	N/A	N/A	79	42.11 ± 4.01	324	41.77 ± 6.27	129	24.01 ± 17.05	N/A	N/A
	N	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**
Gender (male)	139	64.8%	84	75.0%	347	89.1%	142	7.7%	178	46.1%
Race	139		76		343		142		178	
White		63.3%		85.5%		77.3%		83.8%		75.8%
Black		11.5%		6.6%		6.7%		0.0%		4.5%
Native		3.6%		2.6%		2.6%		7.7%		2.2%
American										
Asian		2.2%		0.0%		2.6%		2.1%		6.7%
Native		2.2%		0.0%		0.3%		2.1%		0.0%
Hawaiian/Pacific islander										
Multi-racial		5.8%		2.6%		8.5%		4.2%		9.0%
Other		11.5%		2.6%		2.0%		0.0%		1.7%
Hispanic	135	16.3%	77	6.5%	342	2.6%	132	6.1%	178	6.2%
Education	N/A	N/A	79		346		145		178	
Less than HS				0.0%		2.3%		1.4%		48.3%
HS/GED				20.3%		37.3%		33.1%		20.3%
Some college				64.6%		47.7%		40.0%		27.5%
Bachelor's or >				15.2%		12.7%		25.5%		3.9%
Tenure	N/A	N/A	79		347		145		178	
<1 year				0.0%		4.0%		11.7%		35.4%
1–3 years				20.3%		15.3%		30.3%		36.5%
>3 years				79.8%		80.7%		58.0%		28.0%

For the purpose of this study, we define Hispanic as an individual who identifies as being of Cuban, Puerto Rican, South or Central American, or other Spanish culture of origin regardless of race.

Comparison Across Measures of Safety, Health, Health Behaviors, and Well-Being

Table 2 provides an overview of the safety and health profiles for all worker samples. Ten percent of older adult workers (i.e., 65 and above; call center, construction, corrections, and homecare) reported work-related injuries that resulted in missed work during the past 6 months. Such injuries were highest among construction workers at 16.2%. Forty-seven percent of adult workers reported experiencing pain in the last 6 months that interfered with normal activities. More than 70% of all participants were overweight or obese. In the young worker sample, just over 21% were overweight or obese. Conversely, 83.2% of older adult workers were overweight or obese. Among the adult participants, 16.4% had high blood pressure (HBP) and 41.0% were pre-hypertensive. Approximately 15% of all workers reported smoking in the last week/month. Smoking was lowest among young workers employed by parks and recreation department (4.5%) and highest among construction workers (20.7%). Approximately 60% of all workers reported getting sufficient sleep; as recommended by NIH. Sleep sufficiency was lowest in the young worker sample (46.6%) for whom more sleep is recommended. Only 35% of the workers were getting 150 min of moderate to vigorous physical activity per week as recommended by the CDC. Young workers were more likely to meet exercise guidelines, yet even in this sample, just over 50% met the guidelines. Physical activity was lowest among corrections officers and homecare workers, at just over 20%.

One-sample *t*-tests indicated that construction workers and homecare workers reported being pain-free significantly less often than the U.S. general population ($p < 0.001$); young parks and recreation workers were significantly more pain free ($p < 0.001$). All four of the adult samples had significantly poorer general health ($p < 0.001$) than a nationally representative sample. No evidence could be found that the general health of young workers was significantly different from that of a nationally representative sample. The homecare workers, who were also our oldest sample, had significantly poorer physical functioning than a nationally representative sample ($p < 0.001$). However, all of the other occupational samples had significantly better physical functioning ($p < 0.010_{\text{all 4 samples}}$). Homecare workers scored significantly lower than the nationally representative sample in both role physical and role emotional ($p < 0.010$); that is, they reported feeling limited in their ability to perform role-related responsibilities due to emotional or

TABLE 2 | OHWC descriptive statistics for health, safety, well-being, and health behaviors.

	Call center workers		Correction officers		Constructions workers		Homecare workers		Parks and recreation workers		Combined sample	
	N	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**
Safety												
Work injury that required lost work days	139	2.9%	79	5.1%	346	16.2%	147	4.1	N/A	N/A	572	9.9%
Pain that interfered with normal activities	123	6.3%	79	44.3%	341	56.0%	148	61.6%	N/A	N/A	566	47.0%
Health												
Smoking in past week	138	16.7%[a]	79	12.7%	348	20.7%	147	16.3%[a]	178	4.5%	752	15.4%
Recommended hours sleep (teens 9+ h; adults 7+ h)	139	79.3%	77	56.4%	339	60.2%	N/A	N/A	178	46.6%	594	60.1%
Moderate/vigorous exercise for 30 min for 5 or more days per week	139	43.1%	79	21.5%	346	32.1%	145	22.8%	178	50.6%[b]	748	35.1%
BMI	138		83		335		148		178		744	
Overweight		15.9%		28.9%		31.3%		24.3%		13.5%		23.9%
Obese		60.9%		63.9%		54.0%		54.7%		7.9%		46.8%
Blood Pressure	130		82		336		147	34.7%	N/A	N/A	565	
Pre-hypertension		33.8%		53.7%		51.2%		17.0%				41.0%
Hypertension		10.0%		19.5%		25.3%						16.4%
	N	**M ± SD**	***N***	**M ± SD**	***N***	**M ± SD**	***N***	**M ± SD**	***N***	**M ± SD**	***N***	**M ± SD**
SF-12												
General health	N/A	N/A	79	41.14 ± 10.13***	345	45.60 ± 9.70***	147	44.36 ± 10.25***	178	51.18 ± 9.00	749	46.21 ± 10.15***
Physical functioning	N/A	N/A	78	52.61 ± 6.44**	343	53.09 ± 6.98***	146	46.35 ± 9.97***	178	53.47 ± 7.37***	745	51.81 ± 8.14***
Role physical	N/A	N/A	76	52.39 ± 6.75**	N/A	N/A	145	46.98 ± 9.97***	178	54.33 ± 5.47***	399	51.29 ± 8.31**
Role emotional	N/A	N/A	78	48.34 ± 9.38	N/A	N/A	144	47.81 ± 9.98**	178	49.80 ± 8.87	400	48.80 ± 9.40*
Bodily Pain	N/A	N/A	79	49.19 ± 9.80	348	46.14 ± 11.16***	145	45.92 ± 10.35***	178	53.95 ± 6.32***	750	48.27 ± 10.42***
Mental health	N/A	N/A	79	46.25 ± 10.33**	344	47.94 ± 10.10***	147	47.54 ± 10.66**	178	49.85 ± 9.20	748	48.14 ± 10.07***
Vitality	N/A	N/A	79	48.13 ± 9.32	344	50.15 ± 9.23	147	48.64 ± 10.79	178	52.50 ± 8.50***	748	50.20 ± 9.50
Social functioning	N/A	N/A	79	46.34 ± 11.49**	344	49.23 ± 10.09	147	47.43 ± 10.26**	178	50.61 ± 8.00	748	48.90 ± 9.90**

N in this table represent the number of participants in each sample who answered each question. % in this table indicated the percent of participants who answered in the affirmative out of those who answered the question for each sample.

[a] *Homecare workers and call center workers asked about smoking in the last month.*

[b] *Parks and recreation workers were not asked about the intensity of their exercise.*

Scores for each of the sub-scales of the SF-12 were standardized using the means and SDs of the nationally representative sample and converted to t-scores to be comparable to the nationally representative sample with a mean = 50 and a SD = 10.

****p < 0.001 and **p < 0.010.*

physical health issues. The other worker groups were significantly healthier than the U.S. general population on role functioning ($p < 0.010$), but not statistically different from the U.S. general population on role emotional. All of our adult samples reported poorer mental health than the U.S. general population ($p < 0.010$). The parks and recreations workers scored significantly higher on vitality than the US general population ($p < 0.001$). We found no difference between any of the adult samples and the U.S. general population on vitality. Corrections officers and homecare workers scored significantly lower than the general US population on social functioning ($p < 0.010$).

DISCUSSION

Overview of Findings

Our findings point to a workforce with both health and safety concerns. With regard to safety, 11% of adult workers reported work-related injuries that resulted in missed work and 47% were experiencing pain that interfered with normal activities. Further, many workers in our studies are at risk for chronic health conditions. Over 70% of the overall sample was overweight or obese and 57% of older adult workers were hypertensive or pre-hypertensive. Our findings show that working populations such as those in our studies can benefit from a Total Worker Health approach that targets factors that can improve health, safety, health behaviors, and well-being.

Role of the Work Environment on Safety and Health Outcomes

Studies at the Oregon Healthy Workforce Center have found that while individual behaviors play a role in worker health, safety, and well-being, the workplace environment can also have a large impact, such as access to safety equipment, access to healthy foods, reasonable working hours and breaks, access to opportunities to engage in physical activities at or near work (48–51). In addition, workers who are stressed or injured at work may engage in unhealthy behaviors such as poor diet, lack of physical activity, lack of sleep, and substance abuse, which in turn can contribute to further injuries or chronic health conditions such as obesity or HBP (52, 53). Our findings suggest that there is much need to study and improve working conditions for these occupational groups, with the goal of promoting health, safety, and well-being. Specifically, organizations should influence employee lifestyles through structural changes to the design of work and working conditions that would facilitate engaging in these activities, along with programs that target individual motivation and participation.

In our study, there was a high rate of pain reported among workers in corrections, construction and homecare. Population-based studies indicate that levels of musculoskeletal pain in adults range from 6 to 55% (19, 54). In a large random sample of working adults from one UK region, the prevalence of adults with pain in upper limbs and neck was 50.5%. This UK region had a large percentage of manufacturing workers; however, only 13% reported pain that interfered with functioning. In a large random sample of people from Sweden, 55% of the population perceived consistent pain for three 3 months or more (54). This sample consisted of residents from two regions of the country: one with a high percentage of industrial manufacturing and blue-collar workers and the other with a high percentage of fishing and agricultural workers. Factors found to be associated with musculoskeletal pain included the following: repetitive lifting of heavy objects, prolonged neck bending, working with arms at shoulder height or higher, low job control, low supervisor support, blue-collar occupations, and female gender. Growing evidence suggests that work-related injuries play a part in the opioid epidemic (55, 56). Occupations that require a high degree of manual labor such as construction show a higher likelihood that a worker will develop a dependency on prescription opioids (55).

All of our adult samples had lower levels of mental health than the general US population. Workplace factors associated in the literature with decreased mental health include: high job strain—which is a combination of high demands and low discretionary control over work—low social support at work, effort-reward imbalance, shift work (especially night shift), and long work hours (20, 57–61). Organizational interventions to prioritize mental health by reducing sources of job stress and providing access to employee-assistance programs such as confidential counseling are critical. Similarly, increasing job control may help to decrease stress, improve work-life balance, thereby reducing the risk for stress-related outcomes such as hypertension.

Occupational Differences

A crucial component in identifying cross-population factors related to risks and general wellness at the occupation-level lies in comprehensively understanding the distinct challenges, contexts, and profiles of the workers within each setting (62). Differences between samples could be evidence of structural barriers in workplaces that do not prioritize safety and health behaviors. Research has demonstrated that aspects of the physical environment or nature of work impact safety and health behaviors and related outcomes. For example, at a public health level, the following are related to greater participation in physical activity: accessibility of fitness facilities, the presence of sidewalks, and low-traffic (48). In the work environment, examples of facilitators of physical activity could include pedal stands, having proper work breaks, and safe spaces to walk at work.

Homecare workers had poorer health across several measures compared to the other occupational groups; they also reported greater pain, poorer physical functioning, and role functioning than the U.S. general population. Our previous qualitative research indicated that these homecare workers, who were employed by the consumers or their families, reported low support for safety (32). In an institutional care organization, lifting would be done by a group of workers whereas homecare workers must often do this lifting alone. Because homecare workers are dependent on their consumer and the consumer's case manager to request safety equipment, the process is often unclear for the worker. They also reported poorer well-being as indicated by lower emotional and social functioning than the nationally representative sample. In our previous work we found that homecare workers also reported feeling socially isolated,

having almost no contact with co-workers other than during training sessions. This isolation could contribute to lower well-being among homecare workers. These are some aspects of the work environment that could be targeted to decrease injuries and pain, and improve well-being.

Construction workers had the highest rate of injuries and, like homecare workers, reported a high degree of pain interfering with normal activities. Of all the occupational groups, construction workers had among the highest occupational exposure to posture-related risk factors for injury (21). The vast majority of construction workers were overweight or obese and were pre-hypertensive or hypertensive. Smoking was also more prevalent among construction workers than among the other occupations we assessed. Construction workers would benefit substantially from interventions focused on reducing hazardous exposures and work-related injuries, smoking cessation programs (63), and by training supervisors to better support work-life integration (64), and safety communications (65).

Corrections workers reported less pain than our other samples. They also showed better outcome measures of health (i.e., general health) and well-being (e.g., mental health and social functioning) than the U.S. population in general. They did, however, have among the highest percentage of overweight and pre-hypertension/hypertension of our occupational groups. Further research into how the work environment could be modified to reduce risks of preventable diseases could be particularly useful for these workers.

Younger and Older Workers

There were a variety of notable differences between the younger and older workers. The older workers generally had poorer general and mental health than the general U.S. population. On the other hand, younger workers were no different than the general U.S. population. Research has indicated that reports of pain increase as workers age (54). We saw evidence of this in our sample: two of the older worker samples (homecare and construction) reported significantly more bodily pain than the general population while the young workers reported significantly less pain than the general population. Young workers scored significantly higher on vitality than the U.S. general population ($p > 0.001$); there was no difference between the adult samples and the U.S. general population on vitality. Younger workers, who need more sleep than older adults, were more likely to report inadequate sleep than older workers. TWH interventions geared toward older adults would include healthy pain management strategies (at the individual level) in combination with addressing important changes to the work environment such as providing tools for safe lifting and preventing worksite risks for injuries and accidents. Although young workers are healthier compared with older workers, they could benefit from interventions to increase sleep and physical activity. Intervening with younger workers to establish prevention strategies that are reinforced through their career could be a worthwhile approach that may help to prevent worsening of health conditions as career paths progress (47).

Limitations

Our study has some limitations. All samples were chosen to address the main aims of the sub-studies making up the OHWC. These occupational groups are not meant to be representative of the entire national workforce but rather these specific occupational groups within Oregon. These were convenience samples within single organizations and thus may not be as representative of their respective occupational groups compared to a study using random sampling of all individuals in a certain occupation. The OHWC targets working populations with high burden and need, which should be considered when generalizing our results. When comparing our samples to the national representative sample, we could not match the age or gender of our samples because we did not have the individual data for the national sample. We cannot rule out the influence of other factors beyond working conditions on workers' health, as the data is cross-sectional and we did not measure pre-existing conditions. In addition, more detail on several of our outcomes would allow conclusions that are more precise. For example, we asked about smoking in the past week. We did not ask how long workers had smoked or whether some may have only recently quit. When including common measures across multiple studies that may not be relevant to other aims in is necessary to trade off details for efficiency. Next, all of these data were collected in the State of Oregon. It is possible that regulations in other states or other state-level variables could influence safety and health behaviors and outcomes for workers in similar occupations. In addition, after we began our data collection for these studies, the NIH published PROMIS measures (66–68)—a set of freely available, well-validated measures of various aspects of health, with the objective of standardizing measures across studies. We have adopted these measures for subsequent data collection across projects, but unfortunately, they could not be part of this study. Finally, some measures referenced varying reflective time periods (e.g., smoking a cigarette in the last week vs. last month); thus, direct comparisons on these specific variables should be made with caution. Nonetheless, the Common Measures Data Repository is a promising approach to learning and addressing the unique and shared needs of worker populations across occupations.

Practical Implications and Conclusions

Growing literature suggests that lifestyle behaviors such as getting adequate sleep, exercising regularly, eating a healthy diet, and not smoking can be influenced by work exposures, conditions, and policies (69). Because adults spend a significant amount of their awake hours at work and because work plays an important role in our lifestyle and well-being, the workplace is an opportune platform from which to address health behaviors and outcomes.

Using a common measures approach to understand occupational safety, health, and well-being outcomes across studies can serve to compare and contrast risks, and highlight avenues for interventions to reduce work-related hazards and promote health and well-being. The findings of our common measures analyses point to the potential benefit of a Total Worker Health approach, in particular, integrated interventions that can decrease work-related risk factors and improve facilitators

for pursuing health, safety, and well-being among workers across industries and along the age spectrum. For example, early interventions to reduce risk for injury at work can prevent the experience of pain among older workers, which in turn could improve health and safety behaviors, enhance health outcomes, and overall facilitate long-term quality of life.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because they must be approved by the OHWC Steering Committee. Requests to access the datasets should be directed to Ginger Hanson, ghanson4@jhu.edu.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Oregon Health and Science University and Portland State University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

GH, AR, TB, LH, DR, RO, BW, KK, and NP: conception and design of study. GH, AR, TB, LH, DR, RO, BW, KK, NP, ST, and MP: acquisition of data. GH, AR, TB, and NP: analysis and/or interpretation of data. GH, AR, LA, and AS: drafting the manuscript. AR, TB, LH, DR, RO, BW, and KK: revising the manuscript critically for important intellectual content. All authors contributed to the article and approved the submitted version.

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REFERENCES

1. Hammer LB, Sauter S. Total worker health and work-life stress. *J Occup Environ Med.* (2013) 55(Suppl. 12):S25–9. doi: 10.1097/JOM.0000000000000043
2. Toossi M, Torpey E. *Older Workers: Labor Force Trends and Career Options.* BLS Career Outlook (2017). Available online at: https://www.bls.gov/careeroutlook/2017/article/older-workers.htm (accessed May 21, 2020).
3. World Health Organization. *Preventing Chronic Diseases : A Vital Investment*. WHO Global Report (2005). Available online at: https://www.who.int/chp/chronic_disease_report/full_report.pdf (accessed May 21, 2020).
4. Centers for Disease Control and Prevention. *Chronic Diseases in America.* (2019). Available online at: https://www.cdc.gov/chronicdisease/resources/infographic/chronic-diseases.htm (accessed May 20, 2020).
5. Partnership to Fight Chronic Disease. *Fighting Chronic Disease: The Case for Enhancing the Congressional Budget Analysis Process*. Available online at: http://www.fightchronicdisease.org/sites/default/files/docs/PFCD_ChronDisease_FactSheet3Final.pdf (accessed May 20, 2020).
6. O'Donnell MP, Schultz AB, Yen L. The portion of health care costs associated with lifestyle-related modifiable health risks based on a sample of 223,461 employees in seven industries: the UM-HMRC Study. *J Occup Environ Med.* (2015) 57:1284–90. doi: 10.1097/JOM.0000000000000600
7. Bureau of Labor Statistics. *Nonfatal occupational injuries and illnesses, 1976–2014*. The Economics Daily. Available online at: https://www.bls.gov/opub/ted/2016/nonfatal-occupational-injuries-and-illnesses-1976-2014.htm (accessed May 20, 2020).
8. Young B, Swedlow A. *Obesity as a Medical Disease: Potential Implications for Workers' Compensation*. Available online at: https://www.cwci.org/document.php?file=2008.pdf (accessed May 20, 2020).
9. Burks SV, Anderson JE, Bombyk M, Haider R, Ganzhorn D, Jiao X, et al. Nonadherence with employer-mandated sleep apnea treatment and increased risk of serious truck crashes. *Sleep.* (2016) 39:967–75. doi: 10.5665/sleep.5734
10. National Institute of Occupational Safety and Heath. *Issues Relevant to Advancing Worker Well-being Through Total Worker Health*. Available online at: https://www.cdc.gov/niosh/twh/pdfs/TWH-Issues-4x3_10282015_final.pdf (accessed May 20, 2020).
11. Tamers SL, Chosewood LC, Childress A, Hudson H, Nigam J, Chang C-CC. Total worker health® 2014–2018: the novel approach to worker safety, health, and well-being evolves. *Int J Environ Res Public Health.* (2019) 16:321. doi: 10.3390/ijerph16030321
12. National Institute of Occupational Safety and Health. *NIOSH Centers of Excellence for Total Worker Health*. Available online at: https://www.cdc.gov/niosh/twh/centers.html (accessed May 20, 2020).
13. Oregon Health and Science University. *Oregon Healthy Workforce Center*. Available online at: https://www.ohsu.edu/oregon-healthy-workforce-center (accessed May 20, 2020).
14. Fransson EI, Heikkilä K, Nyberg ST, Zins M, Westerlund H, Westerholm P, et al. Job strain as a risk factor for leisure-time physical inactivity: an individual-participant meta-analysis of up to 170,000 men and women. *Am J Epidemiol.* (2012) 176:1078–89. doi: 10.1093/aje/kws336
15. Heikkilä K, Nyberg ST, Fransson EI, Alfredsson L, De Bacquer D, Bjorner JB, et al. Job strain and tobacco smoking: an individual-participant data meta-analysis of 166 130 adults in 15 european studies. *PLoS ONE.* (2012) 7:e35463. doi: 10.1371/journal.pone.0035463
16. US Census Bureau. *Industry Statistics Portal: Business Data from the US Census Bureau*. Available online at: https://www.census.gov/econ/isp/ (accessed May 20, 2020).
17. Tamers SL, Goetzel R, Kelly KM, Luckhaupt S, Nigam J, Pronk NP, et al. Research methodologies for total worker health®: proceedings from a workshop. *J Occup Environ Med.* (2018) 60:968–78. doi: 10.1097/JOM.0000000000001404
18. Fries JF, Bruce B, Cella D. The promise of PROMIS: Using item response theory to improve assessment of patient-reported outcomes. *Clin Exp Rheumatol.* (2005) 23(5 Suppl. 39):S53–7.
19. Sim J, Lacey RJ, Lewis M. The impact of workplace risk factors on the occurrence of neck and upper limb pain: a general population study. *BMC Public Health.* (2006) 6:234. doi: 10.1186/1471-2458-6-234
20. Clark C, Pike C, McManus S, Harris J, Bebbington P, Brugha T, et al. The contribution of work and non-work stressors to common mental disorders in the 2007 Adult Psychiatric Morbidity Survey. *Psychol Med.* (2012) 42:829–42. doi: 10.1017/S0033291711001759
21. Parent-Thirion A, Biletta I, Cabrita J, Vargas O. *Sixth European Working Conditions Survey:* Overview Report (2016). Available online at: https://www.eurofound.europa.eu/publications/report/2016/working-conditions/sixth-european-working-conditions-survey-overview-report (accessed May 21, 2020).
22. Kajitani S. Which is worse for your long-term health, a white-collar or a blue-collar job? *J Jpn Int Econ.* (2015) 38:228–43. doi: 10.1016/j.jjie.2015.09.002
23. Kim YS, Park J, Rhee KY, Kim HM. A comparison between the second Korean Working Conditions Survey (KWCS) and the First KWCS. *Saf Health Work.* (2015) 6:85–9. doi: 10.1016/j.shaw.2015.02.005

24. Ervasti J, Kivimäki M, Dray-Spira R, Head J, Goldberg M, Pentti1 J, et al. Socioeconomic gradient in work disability in diabetes: evidence from three occupational cohorts. *J Epidemiol Community Health.* (2015) 70:125–31. doi: 10.1136/jech-2015-205943
25. O'Connor Duffany K, Finegood DT, Matthews D, McKeed M, Narayane KMV, Puska P, et al. Community Interventions for Health (CIH): a novel approach to tackling the worldwide epidemic of chronic diseases. *CVD Prev Control.* (2011) 6:47–56. doi: 10.1016/j.cvdpc.2011.02.005
26. Anthony D, Dyson PA, Lv J, Thankappan KR, Fernández MT, Matthews DR. Reducing health risk factors in workplaces of low and middle-income countries. *Public Health Nurs.* (2015) 32:478–87. doi: 10.1111/phn.12189
27. Dyson PA, Anthony D, Fenton B, Matthews DR, Stevens DE. High rates of child hypertension associated with obesity: a community survey in China, India and Mexico. *Paediatr Int Child Health.* (2014) 34:43–9. doi: 10.1179/2046905513Y.0000000079
28. Dyson PA, Anthony D, Fenton B, Stevens DE, Champagne B, Li LM, et al. Successful up-scaled population interventions to reduce risk factors for non-communicable disease in adults: results from the international Community Interventions for Health (CIH) project in China, India and Mexico. *PLoS ONE.* (2015) 10:e0120941. doi: 10.1371/journal.pone.0120941
29. Theorell T, Ahlberghulten G, Sigala F, Perski A, Soderholm M, Kallner A, et al. A psychosocial and biomedical comparison between men in six contrasting service occupations. *Work Stress.* (1990) 4:51–63. doi: 10.1080/02678379008256964
30. Olson R, Wright RR, Elliot DL, Hess JA, Thompson S, Buckmaster A, et al. The COMPASS pilot study: a total worker health^{TM} intervention for home care workers. *J Occup Environ Med.* (2015) 57:406–16. doi: 10.1097/JOM.0000000000000374
31. Olson R, Thompson SV, Elliot DL, Hess JA, Rhoten KL, Parker KN, et al. Safety and health support for home care workers: the COMPASS randomized controlled trial. *Am J Public Health.* (2016) 106:1823–32. doi: 10.2105/AJPH.2016.303327
32. Mabry L, Parker KN, Thompson SV, Bettencourt KM, Haque A, Rhoten KL, et al. Protecting workers in the home care industry: workers' experienced job demands, resource gaps, and benefits following a socially supportive intervention. *Home Health Care Serv Q.* (2018) 37:259–76. doi: 10.1080/01621424.2018.1470590
33. Hammer LB, Truxillo DM, Bodner T, Rineer J, Pytlovany AC, Richman A. Effects of a workplace intervention targeting psychosocial risk factors on safety and health outcomes. *Biomed Res Int.* (2015) 2015:836967. doi: 10.1155/2015/836967
34. Short ME, Goetzel RZ, Pei X, Tabrizi MJ, Ozminkowski RJ, Gibson TB, et al. How accurate are self-reports? Analysis of self-reported health care utilization and absence when compared with administrative data. *J Occup Environ Med.* (2009) 51:786–96. doi: 10.1097/JOM.0b013e3181a86671
35. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon.* (1987) 18:233–7.
36. Ware J, Kosinski M, Turner-Bowker D, Gandek B. *How to Score Version 2 of the SF-12 Health Survey*. Boston, MA: Health Assessment Lab (2005).
37. Centers for Disease Control and Prevention. *Is BMI Interpreted the Same Way for Children and Teens as It Is for Adults? Healthy Weight*. Available online at: http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html#interpreted (accessed May 20, 2020).
38. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr., et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. *J Am Med Assoc.* (2003) 42:1206–52. doi: 10.1001/jama.289.19.2560
39. U.S. Department of Health Human Services. *Ending the Tobacco Epidemic: A Tobacco Control Strategic Action Plan for the U.S. Department of Health and Human Services*. Washington, DC (2010). doi: 10.1001/jama.2012.9741
40. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. *Psychiatry Res.* (1989) 28:193–213.
41. Centers for Disease Control and Prevention. *How Much Sleep Do I Need? Sleep and Sleep Disorders*. Available online at: https://www.cdc.gov/sleep/about_sleep/how_much_sleep.html (accessed May 20, 2020).
42. Centers for Disease Control and Prevention. *Weight Management*. Physical Activity and Health. Available online at: https://www.cdc.gov/physicalactivity/basics/pa-health/index.htm (accessed May 20, 2020).
43. U.S. Bureau of Labor Statsitics. *State Occupational Employment and Wage Estimates Oregon.* Washington, DC (2019).
44. Doughty M. *Corrections: An Oregon Institution Since 1842*. (2020) Available online at: https://www.qualityinfo.org/-/corrections-an-oregon-institution-since-1842 (accessed December 18, 2020).
45. Bodner T, Kraner M, Bradford B, Hammer L, Truxillo D. Safety, health, and well-being of municipal utility and construction workers. *J Occup Environ Med.* (2014) 56:771–8. doi: 10.1097/JOM.0000000000000178
46. Hanson GC, Perrin NA, Moss H, Laharnar N, Glass N. Workplace violence against homecare workers and its relationship with workers health outcomes: a cross-sectional study. *BMC Public Health.* (2015) 15:11. doi: 10.1186/s12889-014-1340-7
47. Rohlman D, Parish M, Elliot D, Hanson G, Perrin N. Addressing younger workers' needs: the Promoting U through Safety and Health (PUSH) trial outcomes. *Healthcare.* (2016) 4:55. doi: 10.3390/healthcare4030055
48. Duncan MJ, Spence JC, Mummery WK. Perceived environment and physical activity: a meta-analysis of selected environmental characteristics. *Int J Behav Nutr Phys Act.* (2005) 2:1–9. doi: 10.1186/1479-5868-2-11
49. Hjarnoe L, Leppin A. A risky occupation? (Un)healthy lifestyle behaviors among Danish seafarers. *Health Promot Int.* (2014). 29:720–9. doi: 10.1093/heapro/dat024
50. Pechey R, Jebb SA, Kelly MP, Almiron-Roig E, Conde S, Nakamura R, et al. Socioeconomic differences in purchases of more vs. less healthy foods and beverages: analysis of over 25,000 British households in 2010. *Soc Sci Med.* (2013). 92:22–6. doi: 10.1016/j.socscimed.2013.05.012
51. Ravesteijn B, Van Kippersluis H, Van Doorslaer E. The contribution of occupation to health inequality. *Res Econ Inequal.* (2013) 21:311–32. doi: 10.1108/S1049-2585(2013)0000021014
52. Caruso C, Hitchcock E, Dick R, Russo J, Schmit J. *Overtime and Extended Work Shifts: Recent Findings on Illness, Injuries and Health Behaviours* Cincinnati, OH: NIOSH Publications Dissemination (2004).
53. Ulutasdemir N, Kilic M, Zeki Ö, Begendi F. Effects of occupational health and safety on healthy lifestyle behaviors of workers employed in a private company in Turkey. *Ann Glob Heal.* (2015) 81:503–11. doi: 10.1016/j.aogh.2015.08.018
54. Andersson HI, Ejlertsson G, Leden I, Rosenberg C, Centre BH, Bromölla. Chronic Pain in a Geographically Defined General Population. *Clin J Pain.* (1993). 9:174–82.
55. Berecki-Gisolf J, Collie A, McClure RJ. Prescription opioids for occupational injury: results from workers' compensation claims records. *Pain Med.* (2014) 15:1549–57. doi: 10.1111/pme.12421
56. Kowalski-Mcgraw M, Green-Mckenzie J, Pandalai SP, Schulte PA. Characterizing the interrelationships of prescription opioid and benzodiazepine drugs with worker health and workplace hazards. *J Occup Environ Med.* (2017) 59:1114–26. doi: 10.1097/JOM.0000000000001154
57. Harrington JM. Health effects of shift work and extended hours of work. *Occup Environ Med.* (2001) 58:68–72. doi: 10.1136/oem.58.1.68
58. Lee A, Myung SK, Cho JJ, Jung YJ, Yoon JL, Kim MY. Night shift work and risk of depression: meta-analysis of observational studies. *J Korean Med Sci.* (2017) 32:1091–6. doi: 10.3346/jkms.2017.32.7.1091
59. Sparks K, Cooper C, Fried Y, Shirom A. The effects of hours of work on health: a meta-analytic review. *J Occup Organ Psychol.* (1997) 70:391–408.
60. Stansfeld S, Candy B. Psychosocial work environment and mental health-a meta-analytic review. *Scand J Work.* (2006) 32:443–62. doi: 10.5271/sjweh.1050
61. Stansfeld SA, Shipley MJ, Head J, Fuhrer R. Repeated job strain and the risk of depression: longitudinal analyses from the Whitehall II Study. *Am J Public Health.* (2012) 102:2360–6. doi: 10.2105/AJPH.2011.300589
62. Pronk NP. Integrated worker health protection and promotion programs: overview and perspectives on health and economic outcomes. *J Occup Environ Med.* (2013) 55(Suppl. 12):S30. doi: 10.1097/JOM.0000000000000031
63. Sorensen G, Stoddard A, Hunt MK, Hebert JR, Ockene JK, Avrunin JS, et al. The effects of a health promotion-health protection intervention on behavior change: the wellworks study. *Am J Public Health.* (1998) 88:1685–90.
64. Hammer LB, Brady JM, Perry ML. Training supervisors to support veterans at work: effects on supervisor attitudes and employee sleep

and stress. *J Occup Organ Psychol.* (2020) 93:273–301. doi: 10.1111/joop.12299

65. Anger WK, Kyler-Yano J, Vaughn K, Wipfli B, Olson R, Blanco M. Total worker health® intervention for construction workers alters safety, health, well-being measures. *J Occup Environ Med.* (2018) 60:700–9. doi: 10.1097/JOM.0000000000001290
66. Cella D, Riley W, Stone A, Rothrock N, Reeve B, Yount S, et al. The patient-reported outcomes measurement information system (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005-2008. *J Clin Epidemiol.* (2010) 63:1179–94. doi: 10.1016/j.jclinepi.2010.04.011
67. Amtmann D, Cook KF, Jensen MP, Chen WH, Choi S, Revicki D, et al. Development of a PROMIS item bank to measure pain interference. *Pain.* (2010) 150:173–82. doi: 10.1016/j.pain.2010.04.025
68. DeWalt DA, Rothrock N, Yount S, Stone AA. Evaluation of item candidates: the PROMIS qualitative item review. *Med Care.* (2007) 45(5 Suppl. 1):S12. doi: 10.1097/01.mlr.0000254567.79743.e2
69. Feltner C, Peterson K, Palmieri Weber R, Cluff L, Coker-Schwimmer E, Viswanathan M, et al. The effectiveness of total worker health interventions: a systematic review for a national institutes of health pathways to prevention workshop. *Ann Intern Med.* (2016) 165:262–9. doi: 10.7326/M16-0626

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Perceived Stress in a Gender Perspective: A Survey in a Population of Unemployed Subjects of Southern Italy

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Stressful life events, are differently handled by women and men. This study evaluates gender differences in perceived stress and health status among a sample of subjects going through a transition period from unemployment to work. This cross-sectional study enrolled 395 participants, 245 men (62%) and 150 (38%) women, between 19 and 67 years, that were going to be hired for a 6-month contract. Before being employed, all participants underwent a mandatory protocol consisting in a general medical check. Stress assessment was performed by using the Perceived Stress Scale (PSS). Most of the participants (68%) showed normal to low perceived stress level. But dividing the sample by gender, out of the remaining 32% with medium to high stress level, 11% male subjects and 22.7% females reported high perceived stress values. We found mean PSS values that are overlapping with those in the general population of developed countries. This study does not suggest an association between perceived stress and health or social parameters. However, our results highlight that the female gender is associated with higher stress level, pointing out the relevance of specific and designed interventions in the context of health promotion programs, especially in order to mitigate stress in more susceptible subjects.

Keywords: perceived stress, unemployment, gender, PSS, work-related stress

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INTRODUCTION

The standard definition of stressful events identifies them as situations in which the demands are likely to exceed the resources of the individual involved (1). It is clear that stress does not inevitably produce negative consequences; but also, that high stress levels, especially when prolonged or accompanied by scarce coping resources, often result to trigger the onset of emotional and mental disorders, such as depression.

The physiological responses producing adaptation to stressful life events involve the hypothalamic-pituitary-adrenal axis and the auto–nomic nervous system, as well as their complex interactions with the metabolic system and the pro- and anti-inflammatory mechanisms of the immune system. Hyperstimulation of this network may lead to alterations in health status (1, 2).

Stress is therefore associated with physical disturbance as an increased risk of cardiovascular diseases (3, 4), metabolic syndromes (5, 6) and mortality (7, 8).

The influence of occupational status on stress is well-known and a close relationship between unemployment and psychophysical health has been demonstrated. In particular, unemployment may become a psychosocial stressor with long term consequences on work ability and the overall state of health, including stress (9). Also job search is a critical moment that can become a source of stress especially for those who cannot achieve economic and psychological independence (10), affecting the global health status. Many studies have investigated perceived stress in general populations (11–16), unemployed (17) and different categories of workers (18), concluding that unemployment and high levels of perceived stress have been associated in cross-sectional studies, but the direction of causation is unknown (19).

A large body of evidence suggests that women and men respond differently to stress and this sex difference could be explained in diverse ways. On the one hand, women not only experience more stressful life events (20) but they also have different coping strategies, that are defined as cognitive and behavioral processes used by an individual to deal with stressful conditions that are judged to be difficult, inexhaustible, hostile, harmful (21). On the other hand, these differences seem to be linked to the genes present on sex chromosomes and gonadal hormones production.

Subjective tools such as questionnaires are used to measure stress levels in workers. In the last 2 decades questionnaires like the Perceived Stress Scale (PSS) have received much attention by researchers; it emerges that the perception of work-related stress -as measured by this scale in terms of unpredictability, lack of control and overload- has a significant impact on worker's quality of life; notwithstanding its characteristic to refer only to the last month, considering that stress is a continually changing state (22, 23).

Upon these premises, this study evaluates perceived stress along with health status and associated factors with a gender perspective, among a representative sample of subjects from southern Italy going through a transition period from unemployment to work.

MATERIALS AND METHODS

Study Design and Population

In this cross-sectional study we investigated an unemployed population that would have been hired for a 6-month contract in the context of socially useful jobs. Subjects came to our observation due to a mandatory preventive protocol required by Italian Decree no. 81/2008, preceding a temporary contract by town Municipality for socially useful jobs such as street sweeping, cleaning green areas and waste bins emptying. All the workers under the mandatory protocol were invited to participate in the study. All participants underwent a general medical check (medical history, physical examination, blood tests, electrocardiogram) between June and September 2019.

Initially, a team of well-trained physicians explained study purpose to all subjects, in order to gain their trust and to obtain the informed consent of those who accepted to participate. The presence of psychiatric illnesses was an exclusion criterion, to avoid confounding effects.

This study was carried out in accordance with the Declaration of Helsinki's ethical standards. Being part of the mandatory occupational health surveillance, the study needed no formal approval by the local Ethics Committee.

Measures

Demographic data included age, sex, education, marital status and number of children while lifestyle and health factors included smoking, body mass index (BMI) and number of comorbidities.

The original 14-item Perceived Stress Scale (PSS-14) was developed in 1983 by Cohen et al. (22) but this first version was later revised and reduced into 10-item and 4-item versions (24–26). The Italian version of the PSS-10 was used to measure to which degree life in the previous month was unpredictable, uncontrollable and overwhelming and it is based on a 5-point response scale (0 = "never," 1 = "almost never," 2 = "sometimes," 3 = "fairly often," 4 = "very often"). After reversing the scores on the four positively stated items (Items 4, 5, 7, and 8), a PSS-10 total score was obtained by summing up all items. Higher scores indicated a higher level of perceived stress. Despite the PSS-10 is not a diagnostic instrument, it provides an output distinguishing four categories depending on different cut-off values (1–10 = "under average," 11–14 = "average," 15–18 = "medium-high," $\geq$19 = "high").

A medical examination was conducted before questionnaire submission in the Occupational Medicine Unit at University Hospital of Messina, starting from 07:45 a.m. (last examination started at 12:30 p.m.) It included past medical history, physical examination (i.e., blood pressure, height, and weight), blood tests (i.e., glucose, blood count) and electrocardiogram (ECG).

The subjects' chronic diseases suffered by (i.e., hypertension, diabetes, cancer, cardiovascular, respiratory, autoimmune, neurological diseases, and obesity) were considered comorbidities.

The body mass index (BMI) was calculated by dividing body weight in kilograms by the square of body height in meters and used to define persons as underweight (BMI $<$ 18.5 kg/m^2), normal (BMI 18.5–24.99 kg/m^2), overweight (BMI 25–29.99 kg/m^2), or obese (BMI $\geq$ 30 kg/m^2).

To evaluate blood pressure levels of each participant, a medical doctor registered a measurement from the right arm (passively supported at the reference level of the right atrium) while the subject was comfortably seated. Threshold values of both systolic ($\geq$140 mmHg) and diastolic ($\geq$90 mmHg) blood pressure were applied in accordance with practice guidelines of the European Society of Hypertension and European Society of Cardiology (27).

In conformity with safety and quality standards, trained physicians performed blood withdrawals from antecubital vein by using a closed vacuum-extraction tube system. Concerning the fasting blood glucose, 100 mg/dL was chosen as the upper normal threshold according to the value ranges used by the

American Diabetes Association in order to identify individuals with prediabetes (28).

ECG recordings were evaluated by a well-trained physician. QT intervals were measured manually and corrected according to the Bazett formula (Q–T corrected = Q–T interval in seconds/$\sqrt{}$R–R interval in seconds). QTc intervals between 430 and 450 ms in males and between 450 and 470 ms in females were considered borderline, QTc above these values were considered as long QTc intervals (29). Long QTc intervals indicate delayed repolarization of myocardial cells (30).

Statistical Analysis

No formal calculation of the sample size was done, as the study was designed to include all subjects who fulfilled the inclusion criteria. Baseline characteristics were summarized using standard descriptive statistics, and a descriptive analysis was done. Continuous variables were presented as mean (SD) or median (interquartile range), as appropriate. Distributions of categorical variables were presented as frequencies and percentages. Sex comparisons of quantitative continuous variables were evaluated using the Student's *t*-test. The association between each categorical variable and sex was evaluated using the chi-square or Fisher's exact test, as appropriate.

For the purposes of the analysis, PSS-10 scores were dichotomized into no/mild perceived stress (PSS-10 $<$ 15) and moderate/severe perceived stress (PSS-10 $\geq$ 15). Univariate logistic regression analysis was used to evaluate the prognostic ability of the population characteristics, individually, to predict the probability of developing moderate/severe perceived stress. Crude odds ratios with 95% confidence intervals are presented. The measure of classification accuracy of the models was assessed using the area under the receiver operating characteristic curve (AUC), also known as c-statistic (C). All hypothesis tests conducted were 2-tailed and a $p < 0.05$ was considered significant. All statistical analyses were performed using the software package SAS Studio (SAS Institute, Inc., Cary, NC).

RESULTS

Population Characteristics

A detailed sample description is summarized in **Table 1**. Out of 485 subjects invited, 396 accepted participation (response rate 81.7%) and 1 was excluded after applying exclusion criteria. Therefore, 395 subjects were included in the study; the sample consisted of 245 men (62%) and 150 (38%) women, aged 19–67 years. The overall mean age was 40.1 years, 41.7 in men and 37.5 in women.

Regarding the educational level, the majority of the sample, 240 (60.8%) individuals (159 men and 81 women) had middle school.

Over 395 subjects, 109 (75 men and 34 women) were unmarried, 261 (161 men and 100 women) were married, 25 (9 men and 16 women) were divorced or widowed. Concerning the number of children, 113 subjects (78 men and 35 women) had no children, 167 (108 men and 59 women) had 1 or 2 children, 115 (59 men and 56 women) had more than 2 children.

Regarding lifestyle habits, it has been shown that 101 men (41.2% of male subjects) and 39 women (26% of female subjects) were smokers.

After calculating the BMI, it was 26.55 $\pm$ 5.11 (mean $\pm$ SD) in men and 25.9 $\pm$ 5.74 in women with no statistically significant difference ($p = 0.256$). The majority of men (57.6%) showed as overweight/obese while most women (53.3%) were normal/underweight.

Concerning health status, 117 participants (75 men and 42 women) showed at least one chronic disease including hypertension (21 subjects, 20 men and 1 woman), diabetes (13 subjects, 12 men and 1 woman), cardiovascular diseases (7 subjects, 4 men and 3 women), respiratory diseases (5 subjects, 2 men and 3 women), cancer (4 subjects, 3 men and 1 woman), autoimmune diseases (4 subjects, 2 men and 2 women), neurological diseases (3 subjects, 2 men and 1 woman), obesity (81 subjects, 49 men and 32 women). Blood tests revealed 53 individuals (41 men and 12 women) with a glucose level $\geq$ 100 mg/dL.

Dealing with blood pressure 62 subjects (48 men and 14 women) had a systolic blood pressure $\geq$ 140 mmHg and 70 individuals (53 men and 17 women) had a diastolic blood pressure $\geq$90 mmHg.

About QTc intervals we found 9 subjects (6 men and 3 women) with borderline values and only 4 (all men) with a long QTc interval.

Perceived Stress Scale

As reported in **Table 2**, generally considering the whole sample, most of the participants (68%) showed a under average/average PSS-10 score, but this percentage highlights a gender difference, as it represents 73.5% of the men group and 59.3% of women (**Figure 1**). In particular, 11% men and 22.7% women showed high PSS values, therefore the percentage resulted double among women.

Afterwards, taking into account PSS mean values and dividing the sample by different categories (age groups, education, marital status, number of children, smoking habit, comorbidities, and BMI), a comparison between men and women groups was performed. Results are reported in **Table 3**.

As a result, we divided the sample by gender and, considering PSS score mean values, a comparison between subgroups inside the same sociodemographic, lifestyle, and health factors categories was performed. The only statistically significant difference was found in the women group between overweight and obese female individuals (*p*-value 0.003).

Individual logistic regression models examining the association between each population characteristics and the development of moderate/severe perceived stress were constructed. This analysis showed that among the numerous characteristics analyzed, only gender was associated with higher perceived stress levels in this population (**Table 4**).

DISCUSSION

The present study evaluated perceived stress along with health status and associated factors with a gender perspective in a

TABLE 1 | Sociodemographic characteristics, lifestyle, and health factors of study population.

	Study population		M		F		
	N	**(%)**	***N***	**(%)**	***N***	**(%)**	***p*-value**
	395		245	(62.02)	150	(37.98)	
SOCIODEMOGRAPHIC FACTORS							
Age							
Mean	40.1		41.7		37.5		**<0.001**
Range	19–67		19–67		20–61		
Age groups							
19–39	207	(52.4)	116	(47.4)	91	(60.7)	**<0.001**
40–59	156	(39.5)	100	(40.8)	56	(37.3)	
≥60	32	(8.1)	29	(11.8)	3	(2.0)	
Education							
Illiterate	7	(1.8)	4	(1.6)	3	(2.0)	0.100
Elementary school	28	(7.1)	16	(6.5)	12	8.0)	
Middle school	240	(60.8)	159	(64.9)	81	(54.0)	
High school	113	(28.6)	64	(26.1)	49	(32.7)	
University	7	(1.8)	2	(0.8)	5	(3.3)	
Marital status							
Unmarried	109	(27.6)	75	(30.6)	34	(22.7)	**0.008**
Married	261	(66.1)	161	(65.7)	100	(66.7)	
Divorced/widowed	25	(6.3)	9	(3.7)	16	(10.7)	
Children (*n*)							
0	113	(28.6)	78	(31.8)	35	(23.3)	**0.006**
1–2	167	(42.3)	108	(44.1)	59	(39.3)	
≥3	115	(29.1)	59	(24.1)	56	(37.3)	
LIFESTYLE AND HEALTH FACTORS							
Smoking habit							
Yes	140	(35.4)	101	(41.2)	39	(26.0)	**0.006**
No	247	(62.5)	139	(56.7)	108	(72.0)	
Ex	8	(2.0)	5	(2.0)	3	(2.0)	
Comorbidities (including obesity)							
0	278	(70.4)	170	(69.4)	108	(72.0)	0.581
≥1	117	(29.6)	75	(30.6)	42	(28.0)	
BMI							
<18.5	11	(2.8)	4	(1.6)	7	(4.7)	**0.030**
18.5–24.99	173	(43.8)	100	(40.8)	73	(48.7)	
25–29.99	130	(32.9)	92	(37.6)	38	(25.3)	
≥30	81	(20.5)	49	(20.0)	32	(21.3)	
Blood pressure							
Systolic ≥ 140 mmHg	62	(15.7)	48	(19.6)	14	(9.3)	**0.007**
Mean systolic (mmHg)	121		125		114		**<0.001**
Diastolic ≥ 90	70	(17.7)	53	(21.6)	17	(11.3)	**0.009**
Mean diastolic (mmHg)	76		79		72		**<0.001**
QTc							
Mean (ms)	378.11		372.02		388.07		**< 0.001**
Normal	382	(96.7)	235	(95.9)	147	(98.0)	0.386
Borderline/Long	13	(3.3)	10	(4.1)	3	(2.0)	
Blood glucose							
Mean (mg/dL)	90.1		93.0		85.4		**0.007**
≥100 mg/dL	53	(13.4)	41	(16.7)	12	(8.0)	**0.010**

Bold values indicate significant results.

TABLE 2 | Perceived stress scale score in a population of unemployed subjects ($N = 395$).

		Study population		M		F		
		N	**%**	***N***	**%**	***N***	**%**	***p*-value**
Perceived stress scale								
PSS	Under average	191	48.4	134	54.7	57	38.0	**0.003**
	Average	78	19.7	46	18.8	32	21.3	
	Medium-High	65	16.5	38	15.5	27	18.0	
	High	61	15.4	27	11.0	34	22.7	

Bold values indicate significant results.

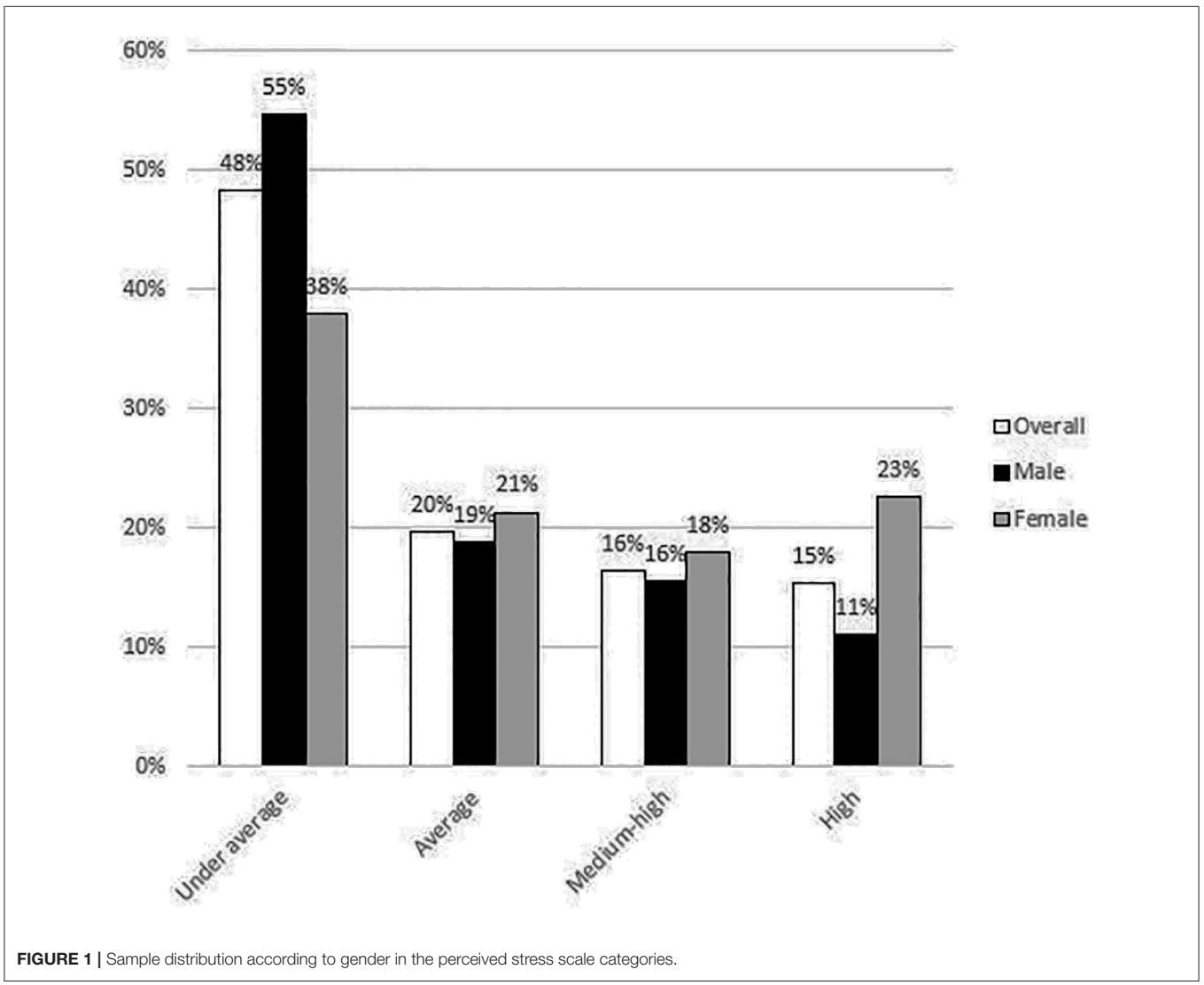

FIGURE 1 | Sample distribution according to gender in the perceived stress scale categories.

sample of 395 southern Italian subjects nearly engaged for a job after a period of unemployment.

Most participants (68%) showed with a under average/average PSS-10 score, meaning that our data are overlapping with PSS-10 values in the developed countries general population (11–13). Considering the existing literature, the results are not in line with the starting hypothesis. Indeed, high levels of perceived stress were expected in unemployed subjects because the lack of employment in those who desire to work has been reported to be associated with increased perceived stress. Taking into account these considerations, it has to be remarked the fact that the study population has been recruited in occasion of a mandatory

TABLE 3 | Mean difference in perceived stress between genders, according to sociodemographic, lifestyle, and health factors.

	M			F				
	N	**Mean PSS**	**SD**	***N***	**Mean PSS**	**SD**	***p*-value**	**CI 95%**
Total	245	10.71	6.1	150	13.11	6.5	**<0.001**	1.17–3.73
Age groups								
19–39	116	10.50	5.80	91	13.30	6.37	**0.002**	1.24–4.47
40–59	100	10.82	6.41	56	12.71	6.39	0.069	−0.22–4.01
≥60	29	11.14	6.80	3	17.33	10.02	0.182	−2.55–14.94
Education								
Illiterate	4	9.50	7.00	3	17.67	4.16	0.060	−3.67–20.00
Elementary school	16	11.81	6.92	12	14.25	6.94	0.296	−3.00–7.88
Middle school	159	10.93	6.26	81	13.65	6.34	**0.002**	1.03–4.42
High school	64	9.97	5.79	49	11.71	6.77	0.152	−0.60–4.09
University	2	10.00	1.41	5	12.40	5.86	0.690	−8.95–13.75
Marital status								
Unmarried	75	11.12	5.72	34	13.53	7.13	0.158	−0.13–4.95
Married	161	10.61	6.38	100	12.83	6.54	**0.004**	0.61–3.84
Divorced/widowed	9	9.00	5.79	16	13.94	4.97	**0.030**	0.40–9.48
Children (*n*)								
0	78	11.38	5.58	35	14.23	6.84	0.067	0.43–5.26
1–2	108	10.69	6.79	59	11.98	6.64	0.170	−0.86–3.45
≥3	59	9.85	5.63	56	13.59	6.08	**<0.001**	1.58–5.91
Smoking								
Yes	101	10.93	6.85	39	14.03	6.06	**0.005**	0.62–5.57
No	139	10.58	5.70	108	12.77	6.61	**0.012**	0.64–3.73
Ex	5	9.60	3.29	3	13.33	10.02	0.416	−7.66–15.13
Comorbidities (including obesity)								
0	170	10.52	6.17	108	13.73	6.58	**<0.001**	0.99–3.71
≥1	75	11.13	6.14	42	11.50	6.11	>0.999	−0.21–8.26
BMI								
<18.5	4	13.00	6.98	7	12.86	6.74	0.927	−9.82–9.53
18.5–24.99	100	10.44	5.54	73	12.89	6.13	**0.013**	0.69–4.21
25–29.99	92	10.35	6.72	38	15.55	6.88	**<0.001**	2.62–7.88
≥30	49	11.73	6.23	32	10.75	6.15	0.515	−3.79–1.82
Blood pressure								
Systolic ≥ 140 mmHg	48	10.67	6.54	14	13.57	7.11	0.095	−1.15–6.96
Systolic < 140 mmHg	197	10.72	6.08	136	13.06	6.47	**<0.001**	0.97–3.71
Diastolic ≥ 90	53	10.81	6.18	17	13.29	7.19	0.161	−1.10–6.06
Diastolic < 90	192	10.68	6.16	133	13.08	6.45	**<0.001**	1.01–3.80
QTc								
Normal	235	10.64	6.18	147	13.10	6.57	**<0.001**	1.15–3.77
Borderline/Long	10	12.30	5.50	3	13.67	2.08	>0.999	−5.95–8.69
Glucose								
≥100 mg/dL	41	10.59	6.43	12	13.83	5.87	0.126	−0.91–7.41
<100 mg/dL	204	10.73	6.12	138	13.04	6.58	**<0.001**	0.95–3.68

Bold values indicate significant results.

preventive medical check prior to employment finalization, and would have started working in the short term; this expectation may have contributed to buffer the perceived stress level that was expected in an unemployed population.

Mean PSS-10 values in our study were 10.71 in men and 13.11 in women with a statistically significant difference ($p < 0.001$). The percentage of women showing high PSS values resulted double than men, as confirmed by the association between female gender and higher levels of perceived stress indicated by the application of logistic regression models. This result parallels other studies showing that women report more stressful life events (20). Large population-based European studies have also

TABLE 4 | Crude OR using univariate logistic regression.

	Moderate/severe perceived stress		
Variable	**OR (95% CI)**	***p*-value**	**C**
Gender			0.577
M	1.0	Ref.	
F	1.898 (1.232–2.932)	**0.004**	

Bold values indicate significant results.

found higher mean PSS scores among women compared with men (12–14).

Stress appears to be differently experienced between genders: emotional exhaustion prevails in women, while men tend to feel more depersonalized. Actually, women seem to be in greater risk for psychological problems, due to the combination of biological and social determinants; these include gender stereotypes, inequity, social segregation, and autonomy (31).

A European multicentric study highlighted gender and regional differences in perceived stress, explaining them with an interaction among culture, economic environment and work organization (32).

In the present study, mean PSS in male subjects showed an increasing trend with age; whereas in women it suggested a decrease with age, though only two of the three women over 60 years presented high PSS values. The three national-level surveys in a United States (US) study (11) reported an increase in the PSS scores with decreasing age, explained by authors as we grow older, we both interpret events as less stressful and develop better coping strategies. Also the study based on a representative survey of the German population (13) highlighted that perceived stress was highest among younger. Whilst these reports are similar to those we found in female subjects; in the male group of our study the perceived stress tends to increase with age. A possible explanation is that the frustration of not being able to find a job grows over time, more in male than in female individuals.

According to the ultimate available OECD data in Italy, higher education level parallels to lower unemployment rate, following the same trend of the European Union countries (33). In this study, only 7 subjects were illiterate and 7 were graduated. Excluding these two extremes, it is possible to observe a decreasing mean PSS with the increasing of the education level, both in men and women. These findings are widely in accordance with other studies in which psychological stress increased in a graded fashion with decreasing education (11) and perceived stress is highest among less educated participants (13). However, as mentioned above, the low perceived stress found in most subjects of our population does not allow to suggest an association with unemployment.

Previous results (13, 34) underlining a high perceived stress in unmarried and divorced subjects are not consistent with our findings, which did not highlight a role of marital status.

Literature reports (13, 14), though not relating perceived stress with children number, are contradictory in considering children a stressor. In this study, participants with children did not feel more stressed; conversely, higher stress was observed in childless subjects, particularly women. This finding may be explained by the controversial psychosocial hypothesis of motherly feel.

A cross-sectional, community-based study based on data from the World Health Survey suggested that perceived stress is significantly associated with higher smoking rates in Africa, Americas, and Asia, but not in Europe. However, in an analysis performed in a representative German sample, unemployment was associated with a 46% higher probability to smoke (35). Our results do not suggest an association between perceived stress and smoking habit in men, whereas stress perception was higher in smoking women.

According to numerous studies and several systematic reviews and metanalyses demonstrating a negative association between unemployment and health (3, 6, 36–38), we found higher stress in subjects who suffered from at least one chronic disease; no statistically significant difference was found intra- and inter-genders.

Stubbs et al. (39) analyzed data from the World Health Organization Study on Global Aging and Adult Health (SAGE), a survey aiming to investigate the relationship between perceived stress, chronic conditions and multimorbidity (i.e., $\geq$2 chronic conditions) in low and middle income countries. In that sample aged $\geq$50, authors identified that over a half had multimorbidity, and greater numbers of chronic conditions were associated with higher levels of stress in a dose-dependent mode. However, hypertension and obesity were not significantly associated with stress in any of the countries. As regards the effect of body weight on perceived stress, literature is not conclusive. In a nationally representative sample of young adults in USA (40), it has been observed that perceived stress is inversely associated with BMI and waist circumference only among men, while others underlined a significant positive relation for both genders (41) or positive associations only for women (42). In our study, the percentage of overweight or obese subjects was differently represented in the two genders (57.6% among men and 46.7% among women); proceeding with the comparison between BMI subgroups, we found stress over average only in overweight women, but unexpectedly not in obese subjects. The reciprocal relation between eating and stress is very complex; it is known that food can become a coping strategy for many individuals, which may explain low stress levels in this population.

AS stress is a potential risk factor also for cardiovascular and neuroendocrine system, these targets were investigated by performing ECG, blood pressure, and glucose measurement.

A study (30) exploring QT interval parameters suggested that conditions associated with work-related stress can have subclinical effects on the autonomic regulation of cardiac function. We found only a few male individuals with long QTc intervals, so an inter-gender comparison is not applicable; despite we found only 6 men and 3 women with borderline QTc values, we can highlight that males showed a higher mean PSS than those with normal QTc. However, due to low stress level in this population, a significant autonomic imbalance was not observed.

Though the relation between stress and hypertension has been widely investigated, it is still a matter of debate (43). No intra-gender variability in PSS scores in all subjects for either systolic or diastolic blood pressure was reported in this population.

Though preliminary results (44) indicated that perceived work-related stress could be associated with increased blood glucose levels, in our results blood glucose was not associated to perceived stress level.

This is, to our knowledge, the first study investigating the relation between stress and unemployment in a middle-aged population of southern Italy with a gender perspective, as other reports (11–13) associated unemployment as a dependent variable to perceived stress.

There are few published surveys focusing on potential geographical and gender differences within specific stressors. They all concluded confirming differences in stress perception according to gender and regional factor; however, both these variables appeared to be weak independent predictors of perceived stress at work (32).

Nonetheless, focusing the complex facets of stress (cultural factors affecting stress perception through coping strategies, home/work interface, social support vs. stigma toward the unemployed subjects, as well as economic environment) is not straightforward; a quantitative instrument administered with standard modalities is presumably inadequate to this purpose. For this reason, we recognize certain limitations to our study. It is a non-prospective observational study, so temporal relationship between perceived stress and the various stressor variables cannot be determined. Also, we did not have the possibility to evaluate PSS over time in order to assess how working activities might have changed perceived stress in an unemployed population. Moreover, the study did not consider social economic status, which can influence perceived stress levels among individuals in a community, assuming that unemployed subjects had a low income and social status. But more importantly, this study design and the questionnaire administered did not allow to focus on other important social aspects as mentioned above.

CONCLUSIONS

Our results highlight that females experience higher perceived stress, pointing out the need for further research investigating gender-specific components of work-related stress. This study design started from the awareness that people react and handle stress differently due to multiple individual and contextual factors which can be difficult to capture in observational studies. PSS-10 showed itself as a reliable, validated and quick scale to measure stress in population samples. However, it does not include items assessing social determinants, so stress level might be underestimated in the current study.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CF and CC: conceptualization and methodology. SI and SM: data analysis and validation. MT, GB, and FV: investigation. GB and MP: resources. SI and AC: writing—original draft preparation. CF, CC, and SI: writing—review and editing. CF: supervision and project administration. All authors have read and agreed to the published version of the manuscript.

REFERENCES

1. Lazarus RS, Folkman S. Stress, appraisal, and coping. In: Lazarus RS, Folkman S, editors. *Health Psychology: A Handbook*. New York, NY: Springer Publishing Company (1984).
2. McEwen BS, Bowles NP, Gray JD, Hill MN, Hunter RG, Karatsoreos IN, et al. Mechanisms of stress in the brain. *Nat Neurosci.* (2015) 18:1353–63. doi: 10.1038/nn.4086
3. Rosengren A, Hawken S, Ôunpuu S, Sliwa PK, Zubaid M, Almahmeed WA, et al. Association of psychosocial risk factors with risk of acute myocardial infarction in 11 119 cases and 13 648 controls from 52 countries (the INTERHEART study): case-control study. *Lancet.* (2004) 364:953–62. doi: 10.1016/S0140-6736(04)17019-0
4. Stansfeld SA, Fuhrer R, Shipley MJ, Marmot MG. Psychological distress as a risk factor for coronary heart disease in the whitehall II STUDY. *Int J Epidemiol.* (2002) 31:248–55. doi: 10.1093/ije/31.1.248
5. Anderson RJ, De Groot M, Grigsby AB, McGill JB, Freedland KE, Clouse RE, et al. Anxiety and poor glycemic control: a meta-analytic review of the literature. *Int J Psychiatry Med.* (2002) 32:235–47. doi: 10.2190/KLGD-4H8D-4RYL-TWQ8
6. Horri N, Haghighi S, Hosseini SM, Zare M, Parvaresh E, Amini M. Stressful life events, education, and metabolic syndrome in women: Are they related? A study in first-degree relatives of type 2 diabetics. *Metab Syndr Relat Disord.* (2010) 8:483–7. doi: 10.1089/met.2010.0015
7. Robinson KL, McBeth J, MacFarlane GJ. Psychological distress and premature mortality in the general population: a prospective study. *Ann Epidemiol.* (2004) 14:467–72. doi: 10.1016/j.annepidem.2003.11.007
8. Huppert FA, Whittington JE. Symptoms of psychological distress predict 7-year mortality. *Psychol Med.* (1995) 25:1073–86. doi: 10.1017/S0033291700037569
9. Bumann A, Niederer D, Santarossa C, Banzer W, Vogt L. How is the self-perceived work ability affected by the duration of unemployment, heart rate variability and the amount of physical activity in older long-term unemployed persons? *Int J Environ Res Public Health.* (2020) 17:2039. doi: 10.3390/ijerph17062039
10. Lim AY, Lee SH, Jeon Y, Yoo R, Jung HY. Job-seeking stress, mental health problems, and the role of perceived social support in university graduates in Korea. *J Korean Med Sci.* (2018) 33:e149. doi: 10.3346/jkms.2018.33.e149
11. Cohen S, Janicki-Deverts D. Who's stressed? Distributions of psychological stress in the united states in probability samples from 1983, 2006, and 2009. *J Appl Soc Psychol.* (2012) 42:1320–34. doi: 10.1111/j.1559-1816.2012.00900.x
12. Nielsen L, Curtis T, Rod Nielsen N, Kristensen TS. What characterizes persons with high levels of perceived stress in Denmark? A national representative study. *Scand J Public Health.* (2008) 36:369–79. doi: 10.1177/1403494807088456

13. Klein EM, Brähler E, Dreier M, Reinecke L, Müller KW, Schmutzer G, et al. The German version of the perceived stress scale - psychometric characteristics in a representative German community sample. *BMC Psychiatry.* (2016) 16:159. doi: 10.1186/s12888-016-0875-9
14. Remor E. Psychometric properties of a European Spanish version of the perceived stress scale (PSS). *Span J Psychol.* (2006) 9:86–93. doi: 10.1017/S1138741600006004
15. Pangtey R, Basu S, Meena G, Banerjee B. Perceived stress and its epidemiological and behavioral correlates in an urban area of Delhi, India: a community-based cross-sectional study. *Indian J Psychol Med.* (2020) 42:80–6. doi: 10.4103/IJPSYM.IJPSYM_528_18
16. Lesage FX, Berjot S, Deschamps F. Psychometric properties of the french versions of the perceived stress scale. *Int J Occup Med Environ Health.* (2012) 25:178–84. doi: 10.2478/s13382-012-0024-8
17. Frasquilho D, de Matos MG, Marques A, Gaspar T, Caldas-de-Almeida JM. Distress and unemployment: the related economic and noneconomic factors in a sample of unemployed adults. *Int J Public Health.* (2016) 61:821–8. doi: 10.1007/s00038-016-0806-z
18. Fenga C, Di Nola C, Maviglia P, Cacciola A, Nardella C. Assessment of occupational stress among shopping centre employees. *G Ital Med Lav Ergon.* (2009) 31 (3 Suppl. B):B56–63. doi: 10.1037/e572992012-391
19. Mæhlisen MH, Pasgaard AA, Mortensen RN, Vardinghus-Nielsen H, Torp-Pedersen C, Bøggild H. Perceived stress as a risk factor of unemployment: a register-based cohort study. *BMC Public Health.* (2018) 18:728. doi: 10.1186/s12889-018-5618-z
20. Kessler RC, McLeod JD, Wethington E. The costs of caring: a perspective on the relationship between sex and psychological distress. In: Sarason IG, editor. *Social Support: Theory, Research and Applications*. Dordrecht, NL: Springer (1985). p. 491–506. doi: 10.1007/978-94-009-5115-0_25
21. Azale T, Fekadu A, Medhin G, Hanlon C. Coping strategies of women with postpartum depression symptoms in rural Ethiopia: a cross-sectional community study. *BMC Psychiatry.* (2018) 18:41. doi: 10.1186/s12888-018-1624-z
22. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav.* (1983) 24:385–96. doi: 10.2307/2136404
23. Marin-Farrona M, Leon-Jimenez M, Garcia-Unanue J, Gallardo L, Crespo-Ruiz C, Crespo-Ruiz B. Transtheoretical model is better predictor of physiological stress than perceived stress scale and work ability index among office workers. *Int J Environ Res Public Health.* (2020) 17:4410. doi: 10.3390/ijerph17124410
24. Cohen S, Hoberman HM. Positive events and social supports as buffers of life change stress. *J Appl Soc Psychol.* (1983) 13:99–125. doi: 10.1111/j.1559-1816.1983.tb02325.x
25. Olsen LR, Mortensen EL, Bech P. Prevalence of major depression and stress indicators in the Danish general population. *Acta Psychiatr Scand.* (2004) 109:96–103. doi: 10.1046/j.0001-690X.2003.00231.x
26. Cohen S, Tyrrell DAJ, Smith AP. Negative life events, perceived stress, negative affect, and susceptibility to the common cold. *J Pers Soc Psychol.* (1993) 64:131–40. doi: 10.1037/0022-3514.64.1.131
27. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, et al. 2018 Practice guidelines for the management of arterial hypertension of the European society of hypertension (ESH) and the European society of cardiology (ESC). *Blood Press.* (2018) 27:314–40. doi: 10.1097/HJH.0000000000001961
28. Mahat RK, Singh N, Arora M, Rathore V. Health risks and interventions in prediabetes: a review. *Diab Metab Syndr Clin Res Rev.* (2019) 13:2803–11. doi: 10.1016/j.dsx.2019.07.041
29. Goldenberg I, Moss AJ, Zareba W. QT interval: how to measure it and what is "normal." *J Cardiovasc Electrophysiol.* (2006) 17:333–6. doi: 10.1111/j.1540-8167.2006.00408.x
30. Lecca LI, Portoghese I, Mucci N, Galletta M, Meloni F, Pilia I, et al. Association between work-related stress and QT prolongation in male workers. *Int J Environ Res Public Health.* (2019) 16:4781. doi: 10.3390/ijerph16234781
31. Boyd A, Van De Velde S, Vilagut G, De Graaf R, O'Neill S, Florescu S, et al. Gender differences in mental disorders and suicidality in Europe: results from a large cross-sectional population-based study. *J Affect Disord.* (2015) 173:245–54. doi: 10.1016/j.jad.2014.11.002
32. De Smet P, Sans S, Dramaix M, Boulenguez C, De Backer G, Ferrario M, et al. Gender and regional differences in perceived job stress across Europe. *Eur J Public Health.* (2005) 15:536–45. doi: 10.1093/eurpub/cki028
33. OECD. *Jobs.* Available online at: https://data.oecd.org/unemp/unemployment-rate.htm (accessed July 27, 2020).
34. Beam CR, Dinescu D, Emery R, Turkheimer E. A twin study on perceived stress, depressive symptoms, and marriage. *J Health Soc Behav.* (2017) 58:37–53. doi: 10.1177/0022146516688242
35. Schunck R, Rogge BG. Unemployment and its association with health-relevant actions: investigating the role of time perspective with German census data. *Int J Public Health.* (2010) 55:271–8. doi: 10.1007/s00038-009-0075-1
36. Prior A, Fenger-Grøn M, Larsen KK, Larsen FB, Robinson KM, Nielsen MG, et al. The association between perceived stress and mortality among people with multimorbidity: a prospective population-based cohort study. *Am J Epidemiol.* (2016) 184:199–210. doi: 10.1093/aje/kwv324
37. Roelfs DJ, Shor E, Davidson KW, Schwartz JE. Losing life and livelihood: a systematic review and meta-analysis of unemployment and all-cause mortality. *Soc Sci Med.* (2011) 72:840–54. doi: 10.1016/j.socscimed.2011.01.005
38. Mousteri V, Daly M, Delaney L. The scarring effect of unemployment on psychological well-being across Europe. *Soc Sci Res.* (2018) 72:146–69. doi: 10.1016/j.ssresearch.2018.01.007
39. Stubbs B, Vancampfort D, Veronese N, Schofield P, Lin PY, Tseng PT, et al. Multimorbidity and perceived stress: a population-based cross-sectional study among older adults across six low- and middle-income countries. *Maturitas.* (2018) 107:84–91. doi: 10.1016/j.maturitas.2017.10.007
40. Suglia SF, Pamplin JR, Forde AT, Shelton RC. Sex differences in the association between perceived stress and adiposity in a nationally representative sample. *Ann Epidemiol.* (2017) 27:626–31. doi: 10.1016/j.annepidem.2017.09.009
41. Harding JL, Backholer K, Williams ED, Peeters A, Cameron AJ, Hare MJL, et al. Psychosocial stress is positively associated with body mass index gain over 5 years: evidence from the longitudinal AusDiab study. *Obesity.* (2014) 22:277–86. doi: 10.1002/oby.20423
42. Chen Y, Qian L. Association between lifetime stress and obesity in Canadians. *Prev Med.* (2012) 55:464–7. doi: 10.1016/j.ypmed.2012.08.013
43. Liu MY, Li N, Li WA, Khan H. Association between psychosocial stress and hypertension: a systematic review and meta-analysis. *Neurol Res.* (2017) 39:573–80. doi: 10.1080/01616412.2017.1317904
44. Sancini A, Ricci S, Tomei F, Sacco C, Pacchiarotti A, Nardone N, et al. Work related stress and blood glucose levels. *Ann Ig.* (2017) 29:123–33. doi: 10.7416/ai.2017.2139

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Factors in the Use of Workplace Health Promotion on Back Health. Results of the Survey "German Health Update"

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Background: The influence of the working environment on the back health of employees is well-documented. Many companies have begun to offer employees access to services to promote back health. Factors affecting the use of these offers at the population level have received little investigation to date. The current study examined the socio-demographic factors, physical activity and health-related factors, and work-related factors associated with the use of offers of workplace health promotion for back health in Germany.

Materials and Methods: In the representative population-based cross-sectional survey "German Health Update" (GEDA 2014/2015-EHIS) conducted by the Robert Koch Institute, 12,072 employees aged 18–64 years old were surveyed from November 2014 to July 2015 regarding the use of back health services in their companies. In addition to socio-demographic factors, the survey examined working hours, physical activity in leisure time, health awareness, and subjective complaints in the lower back or other chronic back problems in the last 12 months. The interaction of these factors with the utilization of back health services was tested using multiple logistic regression models.

Results: Women used back health services more often than men (women: 25.5%; men: 18.1%). Female gender was associated with part-time employment (OR 0.72) and a strong to very strong level of health awareness (OR 1.40). Male gender was associated with age between 30 and 44 years (OR 1.99) and 45–64 years (OR 2.02), low socioeconomic status (OR 0.48), endurance activity of <2.5 h per week (OR 0.62), and absence of lower back pain or other chronic back conditions for the last 12 months (OR 0.48).

Conclusion: The present study is the first to provide findings regarding the factors associated with the utilization of workplace health promotion to promote back health at the population level, and from the perspective of employees in Germany. The results

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revealed that the relevant factors for participating in offers differ for women and men. To reach more employees, workplace health promotion offers for back health should be designed specifically for each individual, considering gender and age, working hours, health awareness and behavior, and health state.

Keywords: workplace health promotion, employees, prevention, self-reported low back health, physical activity, socio-demographic factors, health and work-related factors, German health update (GEDA 2014/2015-EHIS)

INTRODUCTION

A previous systematic review highlighted the influence of the working environment on the back health of employees (1). In context of the workplace, scientific studies indicate especially biomechanical overload due to patients' manual handling as related risk factors for chronic back pain. These include, for example, lifting heavy loads, working in a stooped or twisted posture, vibration, one-sided postures, and repetitive, unilateral movements (2). Also, the importance of psychological risk factors for the development and chronification of musculoskeletal disorders is being recognized and supported by empirical findings. In fact, back complaints occur to a significant extent in industries where light or no physical work is predominant. This indicates the presence of work-related psychosocial conditions such as low job satisfaction, monotonous work, and social conflicts at work as risk factors (3). Furthermore, fear of movement (also known as kinesiophobia) and catastrophizing may influence the development of chronic discomfort and lower performance in the work environment, although these issues are poorly studied (2, 4, 5). Thus, physical activity, ergonomics in the workplace, stress, job satisfaction, social relationships, and company conditions have been identified as important factors in the prevention of back diseases (Medical Service of the German National Association of Health Insurance Funds (MDS) and the National Association of Statutory Health Insurance Funds (6).

Back pain is the second most common individual diagnosis, accounting for 5.9% of cases of incapacity to work and 6.0% of days of incapacity to work (7). At the same time, many companies and health insurance funds have recognized the potential of changes in the working environment to contribute to maintaining the health of employees. Beyond the legally required occupational safety measures, companies are increasingly offering additional measures to promote back health for their employees (6). These and all other joint measures taken by employers, employees, and society to improve health and well-being at work are referred to as Workplace Health Promotion (WHP) (8). Regarding concrete interventions, workplace health promotion can focus on the improvement of working conditions (e.g., by redesigning the work environment as well as the processes and communication structures in the company to improve the health of employees). In addition to the structures in the company, individual measures can also be directed at the health behavior of the employees. Previous studies suggest that combined interventions addressing behavior and conditions are superior to isolated behavioral or even relational preventive measures in terms of their effectiveness and efficiency (9).

The current study focused on behavioral WHP measures for back health such as back school and back exercises. In German companies, these are the most frequently offered individual measures (6). In addition, surveys of employees in Germany show that in the evaluation of all measures for WHP, back training is the most important offer for 65.7% of respondents (10). The overriding objectives of behavioral preventive back health measures are typically to promote exercise for employees in the workplace and to strengthen employees' individual skills and resources in dealing with stress (11). The design and evaluation of the measures involve various challenges, including the often-unclear causes of back pain, the multidimensionality of the identified risk factors and the high variability of frequently recurring symptoms. Thus, the respective approaches applied in back school courses or back exercises are different, ranging from device-supported training to endurance-oriented programs such as running and (Nordic) walking or compensatory gymnastics and breaks from exercise in the workplace to behavioral training and learning relaxation techniques (3). The evidence for different approaches varies with mostly small to moderate effects on their health-promoting effects. For example, this applies to mobilization and stretching programs (12). Metastudies have reported that programs designed to increase physical activity generally reduce both absenteeism due to musculoskeletal disorders and the incidence (number of new cases) and prevalence (incidence of disease) of back disorders (7). However, the existing research is inadequate, and comparable study results are not sufficient to draw firm conclusions about the effectiveness of the various behavioral preventive WHP approaches for promoting back health among employees. Thus, there is still an urgent need for further research (11).

According to the German Federal Statistical Office, in Germany in 2018, 72.1% of women and 79.6% of men of working age were employed (13). In the working environment, it is possible to reach target groups who rarely make use of individual prevention services (e.g., men, young and socially disadvantaged people) (14, 15). Although the number of WHP offers for back health has exhibited a slight upward trend in recent years, data from various surveys of employees show that the participation of employees in company sports and exercise programs, as well as back health programs, remains at a relatively low level (6, 10).

The success of WHP measures for promoting back health, in the sense of lasting change in health behavior at the population level, as well as group-oriented design of offers, depends on individual factors (e.g., age, gender, or health awareness) and contextual characteristics (e.g., working hours) of participants and non-participants. The utilization of WHP measures is

typically assessed using data provided by surveys with employers or the annual prevention report of the National Association of Statutory Health Insurance Funds in Germany, which lists the WHP services supported by the insurance funds (6, 16, 17). In addition to inhouse offers and services provided by private providers, these account for the majority of the total WHP offers provided in Germany. Less frequently, data on the prevalence of WHP measures have been obtained from company employee surveys or population-based surveys of the economically active population (10, 18). The actual use and perception of WHP offers from the perspective of employees thus represents a previously neglected field of research (19). Available results are rarely detailed and provide little insight into the nature of the offerings or the concrete composition of the respective participant groups. In view of the high percentage of the employees with back pain; however, it seems necessary to fill existing gaps in knowledge about factors that influence the utilization of WHP services for back health.

Our study aimed to fill the gap in knowledge about factors that influence the use of workplace health promotion (WHP) offers for back health on the population level, so that future WHP offers can be tailored to the needs of the population. We use a population wide survey on workplace health promotion with data from the perspective of employees, which have been rarely used so far and should allow population wide conclusions. To better understand the factors that are associated with WHP utilization on the population level, we considered factors being of relevance in previous studies on health promotion and prevention, especially on the promotion on back health. At first, these are sociodemographic and -economic factors as age, gender as well as socioeconomic status which have shown to be associated with the use of different individual prevention offers (20–24). Employment status and working hours can be limiting or promoting factors for the participation in WHP (25–27) so we included these employment factors in our analyses. Health behavior in form of "physical activity,", and "health awareness" have been proven to be positive associated with the use of prevention programs (2, 14, 20, 21). At last, back health by the factor "subjective complaints in the lower back or other chronic back conditions" was considered in the analyses, due to results that health conditions are associated with the use of health promoting and prevention measures (17, 28–30). By analyzing these factors in an overall model, we aimed to identify the factors that should be considered in the development of WHP-offers promoting back health in the population in a targeted manner.

MATERIALS AND METHODS

Database

Data from the survey "German Health Update" (GEDA 2014/2015-EHIS) were used to analyze the association between the utilization of company offers for back health and selected determinants of back health (**Table 1**). This survey used web-based and paper-and-pencil questionnaires and was carried out between November 2014 and July 2015 as part of health monitoring by the Robert Koch Institute. The sample is based on statistics from the residents' registration office using a two-stage cluster procedure. The population of the study comprised persons aged 18 years and older with permanent residence in Germany. The topics of the survey are divided into constant core modules on health-relevant issues and a flexible topic in which current public health-relevant focal points are included. In total, 24,016 questionnaires were completed in the study: 10,723 web-based (44.6%) and 13,293 paper-pencil questionnaires (55.4%). The response rate (i.e., the ratio of completed interviews to the total number of people contacted from the population; "response rate 3," American Association for Public Opinion Research) was 26.9% (women 27.5%, men 25.3%). A detailed description of the study methodology was published elsewhere (31, 32).

Outcome Variable

The present study used information provided by the respondents regarding the use of company offers for back health. We first recorded respondents' knowledge of back health offers using an initial question: "Did your company/enterprise offer back health services (e.g., back school, back gymnastics) in the last 12 months?" (answer categories: yes/no/don't know). If the respondent answered yes, the next question asked was: "Have you taken advantage of this offer?" (answer categories: yes/no). To improve the comparability of the data, items from similar studies in Germany were adopted or adapted to GEDA 2014/2015-EHIS accordingly. These studies were carried out in recent years by the scientific institute of 11 regional health insurance funds (WIdO) and the Initiative Health and Work (iga) using representative telephone surveys of employees, mostly in connection with questions about work stress, occupational safety, and health (10, 33).

Predictor Variables

The selection of variables included in the analyses was based on the results of existing research on factors associated with utilization, particularly studies examining offers for workplace health pro-motion and prevention, as well as the promotion of back health in the workplace, with the main focus on research results for Germany (1, 33–36). A number of relevant factors were identified: demographic characteristics (gender and age), socioeconomic status (SES), physical/sporting activity in leisure time and for locomotion, health awareness and subjective complaints in the lower back or other chronic back problems in the last 12 months.

Demographic Characteristics

The following analyses considered female and male participants aged between 18 and 64 years old at the time of the survey. Participants were divided into three age groups: 18–29, 30–44, and 45–64 years.

Socioeconomic Characteristics

Social differences in health of the respondents were analyzed by their SES. SES was calculated based on information about school education and vocational qualifications, occupational status, and needs-weighted net household income. Based on a points-sum index, in which the three indicators were equally weighted,

TABLE 1 | Description of the analysis sample (employees aged between 18 and 64 years); Database: GEDA 2014/2015-EHIS.

		n (unweighted)	% (weighted)	95% CI
Sex	Women	6.610	47.5	46.4–48.6
	Men	5.462	52.5	51.4–53.6
Age	18–29 years	1.662	15.8	15.0–16.7
	30–44 years	4.122	34.1	33.0–35.1
	45–64 years	6.288	50.1	49.0–51.2
Socioeconomic status (SES)	Low	1.418	15.2	14.4–16.1
	Middle	6.700	60.9	59.9–62.0
	High	3.951	23.8	23.0–24.7
	Missing	3		
Employment status	White-collar worker	9.200	73.3	72.2–74.2
	Blue-collar worker	1.795	19.5	18.6–20.4
	Civil servant (also candidate)	1.077	7.3	6.8–7.8
	Missing	0		
Working hours	Part-time	3.681	28.2	27.3–29.2
	Full-time	8.391	71.8	70.8–72.7
	Missing	0		
Minimum 2.5 h of moderately strenuous endurance activities per week	Yes	5.601	45.6	44.5–46.7
	No	6.239	54.4	53.3–55.5
	Missing	232		
Minimum 2 days a week of muscle strengthening activities	Yes	3.420	28.2	27.2–29.2
	No	8.600	71.8	70.8–72.8
	Missing	52		
Health awareness	Very strong	813	6.6	6.1–7.2
	Strong	4.590	36.1	35.1–37.1
	Moderate	5.757	49.3	48.2–50.4
	Less strong	770	6.9	6.4–7.6
	Not at all	100	1.1	0.8–1.3
	Missing	42		
Health awareness (aggregated)	Strong—very strong	5.403	42.7	41.6–43.8
	Less strong—not at all	6.627	57.3	56.2–58.4
Subjective complaints in the lower back or other chronic back problems in the last 12 months	Yes	4.259	37.1	36.1–38.2
	No	7.406	62.9	61.8–63.9
	Missing	407		

CI, confidence interval.

a distribution-based differentiation of three status groups was performed, with the low and high status groups each comprising 20% of the population and the middle status group comprising 60% of the population (26).

Employment Status and Working Hours

Information regarding employment status refers to the participants' subjective assessment of their current situation, in which participants were able to choose one of 13 given answers to the question: "Which life situation applies to you predominantly at present?" Individuals were classified as employed and included in the study if they chose one of the following answers: "I am employed full-time (also vocational training or self-employment, without part-time work for older employees)," "I am employed part-time (also vocational training or self-employment, without part-time work for older employees)," "I am marginally employed (e.g., 450-Euro job, mini-job)." These participants were then asked: "What is your main professional position in your main occupation?," choosing from 12 predefined answer categories. For better comparability with similar national studies, only participants who answered "white-collar worker," "blue-collar worker" or "civil servant (also candidate)" were considered in the following analyses. We excluded all inactive individuals as well as those who stated that they had completed a "voluntary social/ecological/cultural year" or were "voluntary military or federal volunteers." In addition, participants who stated that they were "farmers" as their main occupation, "self-employed (with or without employees)," "helping company employees" or "trainees (including interns, volunteers)" were not considered.

The scope of employment was divided into two categories based on the information on employment status provided by respondents, as described above: "part-time employed" (also

includes part-time workers and persons in partial retirement) and "full-time employed."

Physical Activity in Leisure Time and for Locomotion

Physical activity indicators are based on the World Health Organization (WHO) exercise recommendations for adults, which distinguish between "endurance activities" and "muscle strengthening activities" (37). Respondents are asked four questions about the length of time per week of moderately aerobic physical activity, sport or fitness in leisure time, walking and cycling for locomotion and the number of days per week of physical activity specifically for muscle strengthening. Details regarding indicator formation have already been published elsewhere (38). The following table shows the proportions of participants who spend a minimum of 2.5 h of at least moderately strenuous endurance activities per week (the first part of the WHO exercise recommendation) or muscle strengthening activities for at least 2 days a week (second part of the WHO exercise recommendation). The proportion of participants who fulfilled both parts of the WHO recommendation (2.5 h of endurance plus muscle strengthening activities twice per week) is also shown in the table.

Health Awareness

Health awareness was measured by asking "How much do you generally pay attention to your health?" (very strong/strong/moderate/less strong/not at all) (39). For the evaluations, the combined answers "very strong/strong" and "moderate/less strong/not at all" are shown.

Subjective Complaints in the Lower Back

The "Diseases and complaints" part of the questionnaire was used to record the 12-month prevalence of lower back complaints or other chronic back problems. In addition, it was determined whether these complaints had ever been diagnosed by a doctor. Respondents were asked to answer either "Yes" or "No" to the questions: "Have you had lower back problems or other chronic back problems within the last 12 months?" and "Has this ever been diagnosed by a doctor?."

Statistical Analyses

Analyses were performed with the Stata SE 15.1 statistical package. To correct deviations of the sample from the population structure (as of 31.12.2014) with regard to gender, age, district type and education, a weighting factor was calculated, whereby the district type reflects the degree of urbanization and corresponds to the regional distribution in Germany. A significant difference was assumed if the p-value calculated under consideration of the weighting and survey design was smaller than 0.05. In the following analyses, the frequencies and 95% confidence intervals (CI) of the participant groups will be presented differentiated by gender. Subsequently, logistic regression models were used to analyze the association between the dependent characteristics and utilization, also differentiated by gender. Odds ratios (OR) were used to interpret the relationships. For example, an OR of 2.00 for full-time employed women (reference group of part-time employed women) would indicate that the likelihood of full-time employed women participating in WHP offers for back health was twice as high as that for part-time employed women. The variables were gradually added to the model to identify relevant factors for each group. Model 1 includes demographic and socioeconomic characteristics (age, SES) and the level of employment. Model 2 additionally includes WHO-recommended physical activity (endurance and muscle strengthening activity) and health awareness. In model 3, data on subjective lower back complaints or other chronic back problems in the last 12 months were also considered. Statistically significant results ($p < 0.05$) are reported in the Results section.

RESULTS

Sample Characteristics

Table 1 shows the characteristics of the analysis sample differentiated by demographic and socioeconomic characteristics (gender, age, SES) as well as by employment status and working hours. **Table 1** also shows the distribution of the variables used in the other analyses: endurance activity for at least 2.5 h per week, muscle strengthening activity at least twice per week, health awareness and subjective lower back complaints or other chronic back problems in the last 12 months. The unweighted absolute frequencies as well as the relative frequencies are shown.

Bivariate Analyses

A higher proportion of women (25.5%) than men (18.1%) used their company's offers for back health (**Table 2**) ($p = 0.001$). There were no significant differences between age groups for either gender. Among women, significant differences were found in the group comparisons for two of the potential predictor variables. Regarding to the level of employment, women who were employed part-time were less likely to take advantage of a WHP offer for back health than women who were employed full-time ($p = 0.040$). Furthermore, in terms of health awareness, women who stated that they were strongly or very strongly health-conscious took advantage of such services more frequently than women with a lower level of health awareness ($p = 0.002$). Regarding SES, endurance and muscle strengthening activity, as well as subjective lower back complaints or other lower back complaints in the last 12 months, there were no significant group differences in women. Among male workers, significant group differences were found for four of the potential predictor variables. The results revealed that men with low SES used WHP offers for back health more often ($p = 0.018$) than men with medium or high SES. In addition, men who followed the WHO recommendations for endurance activity ($p = 0.004$) and muscle strengthening activity ($p = 0.013$) used offers more frequently than men who did not follow the recommendations. Men also differed in their use of the company's services depending on whether they reported subjective complaints in the lower back or other chronic back problems. Men with complaints in the last 12 months participated in offers significantly more often than men without complaints.

TABLE 2 | Use of company offers to promote the subjective back health of employees aged 18–64 years (n = 3,069; women: 1,468, men: 1,601) in the last 12 months; Database: GEDA 2014/2015-EHIS.

Offers to promote back health		Women			Men		
		%	95% CI	*P*-value	%	95% CI	*P*-value
Total		25.5	22.8–28.4		18.1	16.0–20.5	
Age	18–29 years	24.4	18.4–31.6	0.533	13.6	8.5–21.0	0.329
	30–44 years	23.8	19.6–28.6		18.7	14.8–23.4	
	45–64 years	27.0	23.0–31.4		18.9	16.3–21.9	
Socioeconomic status (SES)	Low	25.5	14.7–40.3	0.687	27.9	18.8–39.3	0.018
	Middle	26.3	20.9–30.1		18.3	15.4–21.5	
	High	23.6	19.8–27.9		15.4	12.7–18.5	
Working hours	Part-time	22.3	18.3–26.8	0.040	17.5	10.4–27.9	0.886
	Full-time	28.0	24.6–31.6		18.2	15.9–20.7	
Minimum 2.5 h of moderately strenuous endurance activities per week	Yes	26.6	22.9–30.2	0.320	21.0	18.0–24.4	0.004
	No	23.8	20.0–28.0		14.5	11.8–17.8	
Minimum 2 days a week of muscle strengthening activities	Yes	28.4	23.7–33.7	0.126	22.1	18.2–26.5	0.013
	No	24.1	21.1–27.4		16.2	13.7–19.0	
Health awareness	Strong—very strong	29.6	25.7–33.8	0.002	19.9	16.6–23.7	0.183
	Less strong—not at all	21.3	18.0–25.1		17.6	13.9–20.0	
Subjective complaints in the lower back or other chronic back problems in the last 12 months	Yes	28.2	23.9–32.9	0.160	24.9	20.6–29.8	0.000
	No	24.1	20.6–28.0		14.7	12.3–17.6	

CI, confidence interval. Related to all individuals who knew about offers to promote back health in their company.

Regression Analysis

Stepwise multivariate logistic regression revealed significant associations between individual predictor variables and the utilization of WHP offers for back health. The results for women are shown in **Table 3** for each model, and the results for men are shown in **Table 4**. Among female employees, women who worked part-time were less likely to take advantage of offers than women working full-time (**Table 3**). Depending on the regression model, the OR was approximately 0.72 (e.g., Model 3: OR 0.72, 95% CI 0.53–0.98). In addition, a strong to very strong level of health awareness had a significant effect, with an OR of 1.39 in model 2 (95% CI 1.03–1.88) and 1.40 in model 3 (95% CI 1.04–1.89) compared with women with a lower level of health awareness. Women showed no significant effects of age, SES, endurance and muscle strengthening activity, or subjective lower back complaints.

For men, significant results were shown for both age and SES, depending on the model. The likelihood of taking advantage of an occupational offer for back health was approximately twice as high for men in the 30–44 and 45–64 years age groups (model 2: OR 1.99, CI 1.07–3.71 or OR 2.02, CI 1.15–3.54) compared with men aged between 18 and 29 years. In model 3 no significant effects were found for the 45–64 years age group. Compared with men with low SES, the likelihood of utilization by men with high SES was reduced by 0.62 (95% CI 0.26–0.81) in model 1 and reduced by 0.48 in model 2 (95% CI 0.26–0.86). In model 3, SES no longer showed a significant effect. Non-compliance with WHO recommendations for endurance activity was associated with lower likelihood of utilization (e.g., Model 3: OR 0.62, 95% CI 0.44–0.87) as was the absence of lower back pain or other chronic back conditions for the last 12 months (Model 3: OR 0.48, 95% CI 0.34–0.69). The factors working hours, muscle strengthening activity at least twice a week, and health awareness were not relevant for men.

DISCUSSION

Key Results

The present study revealed new insights into the factors associated with the use of company offers for promoting back health from the perspective of the employees in Germany. Data from GEDA 2014/2015-EHIS revealed that, depending on gender, socio-demographic and occupational factors, health awareness, physical activity, and subjective back health were associated with utilization. Thus, women who were employed full-time and women with a strong to very strong level of health awareness exhibited an increased likelihood of using a service to promote back health in their company. For male employees, other factors were found to be relevant. Men who were older than 29 years, those with low SES, those who performed at least 2.5 h

TABLE 3 | Associations between factors and the use of company offers to promote the subjective back health of employees in the last 12 months **for women** (odds ratios and 95% confidence intervals); Database: GEDA 2014/2015-EHIS.

Offers to promote back health	Model 1 Odds ratio (95% CI)	*P*-value	Model 2 Odds ratio (95% CI)	*P*-value	Model 3 Odds ratio (95% CI)	*P*-value
Age						
18–29 years	Ref.		Ref.		Ref.	
30–44 years	1.10 (0.70–1.75)	0.674	1.20 (0.76–1.90)	0.437	1.15 (0.72–1.83)	0.562
45–64 years	1.23 (0.83–1.98)	0.271	1.25 (0.80–1.94)	0.323	1.26 (0.81–1.96)	0.313
SES						
Low	Ref.		Ref.		Ref.	
Middle	1.02 (0.51–2.06)	0.954	0.98 (0.45–2.16)	0.965	1.03 (0.46–2.31)	0.943
High	0.86 (0.43–1.73)	0.663	0.83 (0.38–1.81)	0.634	0.84 (0.38–1.89)	0.682
Working hours						
Full-time	Ref.		Ref.		Ref.	
Part-time	0.71 (0.52–0.96)	0.025	0.72 (0.53–0.98)	0.035	0.72 (0.53–0.98)	0.039
Minimum 2.5 h of moderately strenuous endurance activities per week						
Yes			Ref.		Ref.	
No			0.91 (0.64–1.28)	0.577	0.93 (0.66–1.32)	0.699
Minimum 2 days a week of muscle strengthening activities						
Yes			Ref.		Ref.	
No			0.87 (0.64–1.19)	0.376	0.89 (0.65–1.23)	0.483
Health awareness						
Less strong—not at all			Ref.		Ref.	
Strong—very strong			1.39 (1.03–1.88)	0.029	1.40 (1.04–1.89)	0.028
Subjective complaints in the lower back or other chronic back problems in the last 12 months						
Yes					Ref.	
No					0.84 (0.62–1.15)	0.276

CI, confidence interval; Ref., reference group.

per week active in endurance activities in their free time and/or for exercise, and those who have had lower back problems or other chronic back problems in the last 12 months were more likely to take advantage of WHP promoting back health.

Limitations

The current study involved several limitations that potentially limit the validity of our analyses. All variables we examined were based on self-assessment data, which could potentially lead to memory-related distortions and a bias toward socially desirable responses. In addition, it is also possible that there was not a uniform understanding of WHP in the surveys, and that terms were interpreted differently. For example, information regarding the existence of WHP may have been influenced by employees failing to assign some measures to WHP, and instead assigning them to occupational health and safety, causing a failure to report WHP measures for back health. More detailed information regarding the specific content, duration, structure, intensity, and quality of the behavioral prevention measure was not available, meaning that, for example, a single instance of participation was also included in the calculations. The wording of the question "Was there an offer for back health in your company in the last 12 months" involves ambiguity, which could not be completely counteracted by the addition of "(e.g., back school, back gymnastics)." For example, specific strength or aerobic training or programs such as Pilates and yoga can also be offered to promote back health, but were not explicitly mentioned in the questionnaire and may therefore not have been considered by the respondents.

When interpreting the results, the type of study design should also be considered. The current study had a cross-sectional design that did not allow for causal conclusions to be drawn. In addition, some of the results had large confidence intervals, due to relatively small case numbers for certain subgroups, adding further uncertainty. Also to be considered is the low response rate of 26.9% of GEDA 2014/2015-EHIS. Analyses of the response rate showed differences by age and gender which were therefore included in the weighting factors of the survey that we used for data analyses to adjust the sample distribution to the reference standard for Germany. However, we cannot exclude the possibility that selection bias occurred at the different stages of the sampling procedure (a detailed description of this and further response rate analyses can be found in the detailed methodological reports of the GEDA 2014/2015-EHIS in Saß et al. (32) and Lange et al. (31). Apart from that, the response rate is within the current low range for population-based health surveys in Germany using the same response rate calculation method. In many countries, the survey response rates have continuously decreased in the last decades (40, 41). However, compared to others, for this study design a relatively high degree of representativeness can be assumed.

Interpretation

Regarding the distribution by gender, the results revealed an overall pattern for the use of prevention measures: women

TABLE 4 | Associations between factors and the use of company offers to promote the subjective back health of employees in the last 12 months **for men** (odds ratios and 95% confidence intervals); Database: GEDA 2014/2015-EHIS.

Offers to promote back health	Model 1 Odds ratio (95% CI)	*P*-value	Model 2 Odds ratio (95% CI)	*P*-value	Model 3 Odds ratio (95% CI)	*P*-value
Age						
18–29 years	Ref.		Ref.		Ref.	
30–44 years	1.50 (0.82–2.74)	0.187	1.99 (1.07–3.71)	0.030	1.93 (1.02–3.66)	0.044
45–64 years	1.52 (0.89–2.60)	0.121	2.02 (1.15–3.54)	0.014	1.71 (0.96–3.07)	0.071
SES						
Low	Ref.		Ref.			
Middle	0.59 (0.34–1.03)	0.062	0.67 (0.38–1.17)	0.160	0.68 (0.37–1.23)	0.203
High	0.62 (0.26–0.81)	0.007	0.48 (0.26–0.86)	0.015	0.53 (0.28–1.00)	0.051
Working hours						
Full-time	Ref.		Ref.		Ref.	
Part-time	0.91 (0.47–1.75)	0.768	0.82 (0.41–1.63)	0.571	0.85 (0.41–1.73)	0.642
Minimum 2.5 h of moderately strenuous endurance activities per week						
Yes			Ref.		Ref.	
No			0.64 (0.45–0.90)	0.011	0.62 (0.44–0.87)	0.006
Minimum 2 days a week of muscle strengthening activities						
Yes			Ref.		Ref.	
No			0.77 (0.55–1.07)	0.120	0.75 (0.54–1.05)	0.090
Health awareness						
Less strong—not at all			Ref.		Ref.	
Strong—very strong			1.11 (0.80–1.54)	0.532	1.11 (0.80–1.55)	0.517
Subjective complaints in the lower back or other chronic back problems in the last 12 months						
Yes					Ref.	
No					0.48 (0.34–0.69)	0.000

CI, confidence interval; Ref., reference group.

exhibited a higher rate of usage (25.5%) compared with men (18.1%). In accord with this finding, the Absenteeism Report 2008 and the iga Report 12 also reported higher utilization of services by women (10, 33). The BIBB/BAuA Employment Survey did not reveal significant gender differences for any of the measures, possibly because of the lack of differentiation between various thematic offerings (42). Data from the annual prevention reports of the National Association of Statutory Health Insurance Funds in Germany revealed that WHP promotion by health insurance funds is increasingly common in companies with a higher proportion of men, potentially enabling more men to be reached. However, the report also shows that, for most WHP measures, female employees ultimately have a higher utilization rate than male employees (6). This finding is supported by a review by Robroek et al. reporting that women had a higher likelihood of utilization than men (OR: 1.67 95% CI 1.23–2.27) (36). Beyond the workplace setting, studies in Germany have reported that statutory health insurance funds reach considerably more women than men with their behavioral prevention offerings for general prevention (6, 21, 22, 43, 44). One potential reason for the higher utilization by female employees is that women are generally more health-conscious and are more likely to show health-promoting behavior and/or lower risk behavior than men in many areas (14). For example, regarding the use of health services by women, a higher level of sensitivity to the body and health and a greater willingness to accept help have been reported (35). For men, often the manifestation of an illness or a perceived burden of suffering, such as pain, is required for the use of medical services to reach the same extent as that of women (20).

In investigating the causes of gender inequality, particularly in the context of the use of WHP, factors on the supply side should also be considered, rather than focusing exclusively on the demand side. For example, increased usage in female employees may arise from the gender-neutrality of offers, with fewer offers being specifically designed for men (45). The current statutory health insurance funds prevention report for the reporting year 2018 shows that only 5% of WHP offerings were targeted specifically to women, and 4% were targeted to men (6). Thus, the design, targeting and availability of current back health care offers may appeal more to people with the abovementioned attitudes, which are more common among women, and this may lead to better outcomes.

The current findings revealed that age was not associated with the use of the WHP offers for back health among female employees. Other studies have reported contradictory results regarding age in women, finding both higher and lower participation rates among older female employees (36). For male employees, however, age was a relevant factor in the current study. According to the results, men in the 30–44 and 45–64 years age groups were twice as likely to take advantage of a WHP offer for back health compared with those aged 18–29 years old. This could indicate that the offers are less tailored to the needs of younger men. As discussed in the previous section, it is often the manifestation of an illness or a perceived psychological strain

that causes men to make use of medical services or preventive health care. Because chronic musculoskeletal disorders and stress experienced at work typically increase with age, this could provide a further explanation for the finding that younger men in particular were less likely to address health in the absence of more serious physical or psychological stress symptoms (22). Previous studies have not revealed the extent to which offers are also age- and gender-sensitive and which factors are associated with the use of WHP offers for back health among men of different ages.

As with age, SES was not associated with the use of back health services among female respondents. In contrast, male employees with low SES were more likely to make use of the services compared with those with high SES. In addition, this effect weakened when interacting with the factor of subjective lower back complaints or other chronic back problems in the last 12 months. This finding was in accordance with the gender and utilization results for men discussed above. However, interpreting these results is difficult because we are not aware of any comparative data from other studies of gender-specific differences in SES and the use of back health offers in workplace settings. Overall, however, the current results for both women and men should be viewed positively, as they did not confirm the findings of previous population-based studies for Germany. Several previous studies examining contextual factors have reported that women and men with high SES more frequently make use of health promotion and prevention programs and training opportunities (14, 44). These previous findings indicate that reducing socially induced health inequalities is an important challenge for public health (44). Low SES and low levels of education are considered to be indicators of social disadvantage and are associated with risk factors and poorer health. Although there is a need for prevention in all SES groups, the need is greater among people with low SES (24). The present study indicates that WHP offers for the promotion of back health have a valuable potential to reach employees across SES groups. This potential should be utilized to a greater extent in the future.

Regarding working hours, women who worked full-time were more likely to take advantage of offers to promote back health in their company compared with women working part-time. For men, employment level did not have a significant effect. The possible associations between the actual working hours of women and men in part-time employment and the extent to which they were utilized could not be deduced from the current study data. In general, other studies have indicated that employees in precarious employment situations (part-time/limited term/temporary) are less likely to take advantage of WHP interventions than employees in full-time, permanent, or non-temporary employment (35). When interpreting the results of female employees, it should be considered that there are pronounced differences in working hours between women and men in Germany (27). A significantly higher proportion of women work part-time, primarily in the family phase, potentially explaining why the factor of employment volume was only associated with utilization among female employees.

In the current study, physical activity was understood in terms of two indicators: "endurance activities" and "activities to strengthen muscles." These indicators showed no relevant associations with utilization among female employees. Men who performed endurance activity for at least 2.5 h per week; however, were more likely to utilize WHP offers for back health. This result corresponds to central assumptions of known health behavioral patterns not specifically referring to WHP. These assumptions suggest that measures to promote physical activity are more frequently taken up by population groups that are already physically active (46). In addition, the results of other studies outside the WHP context have suggested that men are generally more often and more intensively physically active in their leisure time than women (37). One potential explanation for the association between physical activity and the use of WHP back health services, particularly among male employees, is that they may feel less attracted to the content and setting of back school or back exercises in the workplace. Thus, unlike women, for whom the indicators for physical activity were not associated with utilization, men who are not very physically active may not have felt that WHP offers for back health addressed their needs. Comparable analyses of other studies in the company context, particularly for male employees, are not available.

A previous study reported that the use of preventive measures is associated with health awareness (14). This association was also found in the present study, but only revealed significant effects among female employees. Although there are was no similar pattern for men, women with a strong to very strong level of health awareness were more likely to advantage of offers to promote back health compared with women with a low level of health awareness. Overall, health behavior can be explained primarily based on various subjective expectations, some of which have been empirically confirmed. For example, the expectation that individual actions can have positive effects on health influences health behavior and thus the use of preventive measures (45, 47). However, because previous studies of health awareness and health-related behavior have generally been conducted outside the working environment, it remains unclear whether and to what extent the described cause-and-effect relationships of health behavior are valid for predicting health-related actions in the workplace, particularly the use of WHP offers to promote back health.

Among men, subjective complaints about the lower back or other chronic back problems within the last 12 months were associated with the use of the services for the promotion of back health. This result was not observed for female employees. A previous study reported that, compared with healthy employees, groups who perceive their own health status as "poor" perform less sport (37), but more often take advantage of company prevention and health promotion programs (29). A perceived level of suffering or perceived "vulnerability" and the "risk" of limitations due to back pain or ailments are thus likely to motivate male employees in particular to take advantage of back schools or back exercises in the workplace. Such processes are also assumed to be an important factor in various models of

behavioral change, such as the health-belief model (28) and the social-cognitive process model of health-related action (30).

Generalisability

Our study design enables statements about WHP offers on back health for adult employees in Germany. We collected date on the use of measures at the population level with a representative sample, with the ability to include information about non-participants in the analyses. The factors examined – age, gender, social status, health awareness and behavior, back related health status, employment, and working conditions—could provide guidance on how individual WHP on back health interventions can be improved at the local level for providers and companies to better reach different target groups. However, this also applies to programs on a regional level. Furthermore, our findings are also useful for other countries, as back disorders are an overarching problem in the working population. However, not all factors with a potential effect on participation in WHP measures for back health, could be considered in this study. On one hand, these are missing information on the WHP offer itself like content or quality of the program. On the other hand, these are context factors at the workplace, for example the importance of work-related physical overload for the development of back disorders. High physical demands at the workplace, such as heavy lifting and carrying, can aggravate the symptoms of back pain, which in turn can increase the need to participate in back health measures. Such associations, as well as the influence of these and other relevant factors on the results of this work, thus remain unclear, but might interact with our analyzed factors. To better understand the use of WHP on back health, further research is necessary, particularly factors that promote and inhibit back health and the interactions between these factors on the individual and contextual level.

CONCLUSION

Various studies have examined the growing spread of WHP offers for the promotion of back health among employees in Germany. However, the actual use and perception of these offers from the perspective of employees represents a relatively neglected field of research. Our study is one of the first in this research field to report the use of WHP from the users' perceptions. Furthermore, the special added value of our study is to present the first analyses of socio-demographic and -economic, work-, physical activity-, as well as health -related factors on the use of WHP on back health being representative for the population in Germany. Thus, it provides various aspects where to improve WHP on back health.

Our data indicated that different factors were relevant for women and men in taking advantage of company offers to promote back health. In addition to the finding that female employees were more likely to use offers than their male colleagues, women's participation was associated with the level of employment and health awareness. In contrast, for men, age, socioeconomic status, physical activity in leisure time and subjective back complaints were relevant factors in whether they made use of the services.

More frequent use by women working full-time highlights the need to address the needs of people with family and professional responsibilities. In addition, in view of the results among female employees, possible barriers due to reduced health awareness should be examined, and, if necessary, removed. Because the lowest utilization rate among male employees was in the 18–29 years age group, gender- and age-sensitive offers to promote back health in companies should also play a greater role in the future. For example, younger men may be more likely to focus on performance and competition than on other motivations and could be given greater consideration in the design of services (48). A frequently cited point of criticism regarding the prevention dilemma is that behavioral preventive measures to promote physical or sporting activity are often utilized by groups of the population that already have a practice of exercise-related behavior (14). The results of the current study highlight the importance of creating offers that also reach less physically or athletically active men. This could be achieved, for example, by applying particularly low-threshold concepts that consider people with different levels of experience with regard to physical or sporting activity, or individual incentive systems. In addition, it will be important for companies to strengthen positive attitudes toward health-promoting and preventive behavior (e.g., through healthy leadership behavior among employees). At the same time, this could also counteract the trend for many individuals, particularly male employees, to only take advantage of offers to promote back health if they already have back pain or a chronic back disease.

Further determinants of the use of WHP in general and back health offers should be studied. These include work-related psychosocial risk factors, social support in the company (including acceptance and support by managers), biomechanical workloads, occupational status, lack of time, service design, company size, expectations of self-effectiveness, and skills for self-motivation. The dissemination of quality standards in the design of WHP should then be promoted, as should the dissemination and use of company services to promote back health.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: The GEDA 2014/2015-EHIS datasets on which the results are based are archived in the Research Agenda Center Health Monitoring at the Robert Koch Institute and are available to interested researchers on request. The dataset can be accessed on site in the Secure Data Center of the RKI's Health Monitoring Research Data Center. Inquiries can be made at the following e-mail address: fdz@rki.de.

AUTHOR CONTRIBUTIONS

SH wrote the manuscript and conducted the statistical analysis. AS, RG, and SJ assisted in the critical revision. SH, AS, and

SJ designed the present study, developed the analysis plan, and interpreted the results. All authors read and approved the final manuscript.

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REFERENCES

1. Pieper C, Schröer S, Haupt J, Kramer I. Wirksamkeit und Nutzen betrieblicher Prävention iga. Report 28. AOK-Bundesverband, BKK-Dachverband, e.V. Deutsche Gesetzliche Unfallversicherung, Verband der Ersatzkassen, e.V. Initiative Gesundheit und Arbeit. Berlin: *Wirksamkeit und Nutzen betrieblicher Gesundheitsförderung und Prävention*. Zusammenstellung der wissenschaftlichen Evidenz (2015). p. 11–109.
2. Lecca LI, Fabbri D, Portoghese I, Pilia I, Meloni F, Marcias G et al. Manual handling of patients: role of kinesiophobia and catastrophizing in health workers with chronic low back pain. *Eur J Phys Rehabil Med.* (2020) 56:307–12. doi: 10.23736/S1973-9087.20.06004-9
3. Lühmann D, Zimolong B. Prävention von Rückenerkrankungen in der Arbeitswelt. In: Badura B, Schellschmidt H, Vetter C, Baase CM, editors. *Chronische Krankheiten: betriebliche Strategien zur Gesundheitsförderung, Prävention und Wiedereingliederung. Fehlzeiten-Report 2006*. Heidelberg: Springer Medizin (2007). p. 63–97. doi: 10.1007/978-3-540-34368-4_4
4. Luque-Suarez A, Martinez-Calderon J, Falla D. Role of kinesiophobia on pain, disability and quality of life in people suffering from chronic musculoskeletal pain: a systematic review. *Br J Sports Med.* (2019) 53:554–9. doi: 10.1136/bjsports-2017-098673
5. Wertli MM, Rasmussen-Barr E, Held U, Weiser S, Bachmann LM, Brunner F. Fear-avoidance beliefs-a moderator of treatment efficacy in patients with low back pain: a systematic review. *Spine J.* (2014) 14:2658–78. doi: 10.1016/j.spinee.2014.02.033
6. Medizinischer Dienst des Spitzenverbandes Bund der Krankenkassen (MDS), GKV-Spitzenverband. *Präventionsbericht 2018. Leistungen der Gesetzlichen Krankenversicherung: Primärprävention und betriebliche Gesundheitsförderung. Berichtsjahr 2017*. Essen: MDS, GKV-Spitzenverband (2018).
7. Badura B, Ducki A, Schröder H, Klose J, Meyer M. *Fehlzeiten-Report 2018*. Berlin, Heidelberg: Springer (2018) doi: 10.1007/978-3-662-57388-4
8. European Network for Workplace Health Promotion (ENWHP), (editors.). *"Luxembourg Declaration on Workplace Health Promotion in the European Union"*. ENWHP (2007). Available online at: https://www.enwhp.org/resources/toolip/doc/2018/05/04/luxembourg_declaration.pdf (accessed November 19, 2020).
9. Initiative Gesundheit und Arbeit (Iga), (editors.). *Wirksamkeit und Nutzen arbeitsweltbezogener Gesundheitsförderung und Prävention. Zusammenstellung der wissenschaftlichen Evidenz für den Zeitraum 2012 bis 2018. Iga-Report 40*. Berlin: Iga (2019).
10. Zok, K. Stellenwert und Nutzen betrieblicher Gesundheitsförderung aus Sicht der Arbeitnehmer. *In*: Badura B, Schröder H, Vetter C, editors. *Fehlzeiten-Report 2008*. Berlin, Heidelberg: Springer (2009). p. 85–100. doi: 10.1007/978-3-540-69213-3_9
11. Flothow A, Kuhnt U (editors.). *Rückengesundheit in der Arbeitswelt: BdR-Manual zum Betrieblichen Gesundheitsmanagement in Theorie und Praxis. 1. Auflage*. München: Elsevier (2018).
12. van Eerd D, Munhall C, Irvin E, Rempel D, Brewer S, van der Beek AJ, et al. Effectiveness of workplace interventions in the prevention of upper extremity musculoskeletal disorders and symptoms: an update of the evidence. *Occup Environ Med.* (2016) 73:62–70. doi: 10.1136/oemed-2015-102992
13. Statistisches Bundesamt (StBA). *Bevölkerung und Erwerbstätigkeit. Erwerbsbeteiligung der Bevölkerung. Ergebnisse des Mikrozensus zum Arbeitsmarkt*. Wiesbaden: StBA (2019). Available online at: https://www.destatis.de/DE/Themen/Arbeit/Arbeitsmarkt/Erwerbstaetigkeit/Publikationen/Downloads-Erwerbstaetigkeit/erwerbsbeteiligung-bevoelkung-2010410187004.pdf?__blob=publicationFile (accessed September 9, 2020).
14. Jordan S, von der Lippe E. Prevention programmes – who takes part?. *GBE kompakt.* (2012) 3. doi: 10.25646/3041.8
15. Payne J, Cluff L, Lang J, Matson-Koffman D, Morgan-Lopez A. Elements of a workplace culture of health, perceived organizational support for health, and lifestyle risk. *Am J Health Promot.* (2018) 32:1555–67. doi: 10.1177/0890117118758235
16. Hollederer A, Wießner F. Prevalence and development of workplace health promotion in Germany: results of the IAB Establishment Panel 2012. *Int Arch Occup Environ Health.* (2015) 88:861–73. doi: 10.1007/s00420-014-1012-z
17. Faller G. Implementierung von Betrieblicher Gesundheitsförderung und Betrieblichem Gesundheitsmanagement - Bedingungen und Herausforderungen. *Public Health Forum.* (2018) 26:134–7. doi: 10.1515/pubhef-2018-0034
18. Beck D, Lenhardt U, Schmitt B, Sommer S. Wovon hängt die Verbreitung unterschiedlicher Niveaus betrieblicher Gesundheitsförderung ab? Vertiefende Analysen der repräsentativen Arbeitgeberbefragung 2011 für die GDA-dachevaluation. *Gesundheitswesen.* (2014) 76. doi: 10.1055/s-0034-1386854
19. Nöhammer E, Eitzinger C, Schaffenrath-Resi M, Stummer H. Zielgruppenorientierung und betriebliche Gesundheitsförderung. *Praev Gesundheitsf.* (2009) 4:77–82. doi: 10.1007/s11553-008-0154-9
20. Härtel U. Geschlechtsspezifische Inanspruchnahme medizinischer Hilfe. Ergebnisse der Münchner Blutdruckstudie. *Soz Praventivmed.* (1988) 33:148–54. doi: 10.1007/BF02078422
21. Hiller J, Schatz K, Drexler H. Gender influence on health and risk behavior in primary prevention: a systematic review. *Z Gesundh Wiss.* (2017) 25:339–49. doi: 10.1007/s10389-017-0798-z
22. Janßen C, Sauter S, Kowalski C. The influence of social determinants on the use of prevention and health promotion services: results of a systematic literature review. *Psychosoc Med.* (2012) 9:Doc07. doi: 10.3205/psm000085
23. Keil J, Brendler V, Sachse C, Zülke A, Zeynalova S, Engel C, et al. Geschlechterspezifische Inanspruchnahme von Gesundheitsleistungen in einer urbanen Erwachsenenpopulation. *Gesundheitswesen.* (2020) 82:e17–23. doi: 10.1055/a-0820-3584
24. Rieder A, Lohff B (editors.). *Gender Medizin: Geschlechtsspezifische Aspekte für die klinische Praxis. Zweite, überarbeitete und erweiterte Auflage*. Vienna: Springer (2008). doi: 10.1007/978-3-211-68290-6
25. Jordan S, Hermann S, Starker A. Utilisation of canteens offering healthy food choices as part of workplace health promotion in Germany. *J Health Monitoring.* (2020) 5:35–42. doi: 10.25646/6401
26. Kroll LE, Lampert T. Gesundheitliche ungleichheit bei erwerbstätigen männern und frauen - ergebnisse der GEDA-studie (2010). *Gesundheitswesen.* (2013) 75:210–5. doi: 10.1055/s-0033-1341446
27. Wanger, S. *Frauen und Männer am Arbeitsmarkt: Traditionelle Erwerbs- und Arbeitszeitmuster sind nach wie vor verbreitet, IAB-Kurzbericht, No.4/2015*. Nürnberg: Institut für Arbeitsmarkt- und Berufsforschung (IAB) (2015).
28. Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall (1986).
29. Busch C, Ducki A. Gesundheitsförderung für Un- und Angelernte: ReSuM. *Public Health Forum.* (2011) 19:22–4. doi: 10.1016/j.phf.2011.06.012
30. Reuter T, Schwarzer, R. Verhalten und Gesundheit. In: J. Bengel, M. Jerusalem, editors. *Handbuch der Gesundheitspsychologie und Medizinischen Psychologie*. Göttingen: Hogrefe. (2009) p. 34–45.

31. Lange C, Finger JD, Allen J, Born S, Hoebel J, Kuhnert R, et al. Implementation of the European health interview survey (EHIS) into the German health update (GEDA). *Arch Public Health.* (2017) 75:40. doi: 10.1186/s13690-017-0208-6
32. Saß, AC, Lange C, Finger JD, Allen J, Born S, Hoebel J, et al. Gesundheit in Deutschland aktuell – Neue Daten für Deutschland und Europa. Hintergrund und Studienmethodik von GEDA 2014/2015-EHIS. *J Health Monitor.* (2017) 2:83–90. doi: 10.17886/RKI-GBE-2017-012
33. Bödeker W, Hüsing, T (editors.). *Einschätzungen der Erwerbsbevölkerung zum Stellenwert der Arbeit, zur Verbreitung und Akzeptanz von betrieblicher Prävention und zur krankheitsbedingten Beeinträchtigung der Arbeit —2007. Iga-Report 12. Iga-Barometer 2. Welle*. Essen: Initiative Gesundheit und Arbeit (Iga) (2008).
34. Alaze F, Brandt M, Goedicke A, Kunze D, Seiler K, Ducki A. Gesundheitsförderung bei Führungskräften und Beschäftigten in Klein(st)betrieben des Gastgewerbes und des Handwerks. In: Jeschke S, Richert A, Hees F, Jooß C. editors. *Exploring Demographics*. Wiesbaden: Springer Spektrum (2015) p. 311–32. doi: 10.1007/978-3-658-08791-3_31
35. Köper B, Siefer A, Beermann B. Geschlechtsspezifische Differenzierung von BGF-Konzepten. In: Badura, Bernhard, Helmut Schröder, Joachim Klose, Katrin Macco, editors. *Fehlzeiten-Report 2010*. Berlin, Heidelberg: Springer (2010). p. 215–23. doi: 10.1007/978-3-642-12898-1_22
36. Robroek SJ, van Lenthe FJ, van Empelen P, Burdorf A. Determinants of participation in worksite health promotion programmes: a systematic review. *Int J Behav Nutr Phys Act.* (2009) 6:26. doi: 10.1186/1479-5868-6-26
37. Finger JD, Mensink GBM, Lange C, Manz K. Gesundheitsfördernde körperliche Aktivität in der Freizeit bei Erwachsenen in Deutschland. *J Health Monitor.* (2017) 2:37–44. doi: 10.17886/RKI-GBE-2017-027
38. Finger JD, Tafforeau J, Gisle L, Oja L, Ziese T, Thelen J, et al. Development of the European Health Interview Survey – Physical Activity Questionnaire (EHIS-PAQ) to monitor physical activity in the European Union. *Arch Public Health.* (2015) 73:59. doi: 10.1186/s13690-015-0110-z
39. Gould SJ. Health consciousness and health behavior: the application of a new health consciousness scale. *Am J Prev Med.* (1990) 6:228–37. doi: 10.1016/S0749-3797(18)31009-2
40. Davern M, McAlpine D, Beebe TJ, Ziegenfuss J, Rockwood T, Call KT. Are lower response rates hazardous to your health survey? An analysis of three state telephone health surveys. *Health Serv Res.* (2010) 45:1324–44. doi: 10.1111/j.1475-6773.2010.01128.x
41. Tolonen H, Helakorpi S, Talala K, Helasoja V, Martelin T, Prattala R. 25-year trends and socio demographic differences in response rates: Finnish adult health behaviour survey. *Eur J Epidemiol.* (2006) 21:409–15. doi: 10.1007/s10654-006-9019-8
42. Beck D, Lenhardt U. Betriebliche Gesundheitsförderung in deutschland: verbreitung und inanspruchnahme. Ergebnisse der BIBB/BAuA-Erwerbstätigenbefragungen 2006 und. 2012 *Gesundheitswesen*. (2016) 78:56–62. doi: 10.1055/s-0034-1387744
43. Kuhn J, Reisig V, Schulz R, Reineke B, Bolte G. Die Wirksamkeit von Präventionsmaßnahmen aus der Sicht der Bevölkerung. In: Böcken J, Braun B, Meierjürgen R, editors. *Gesundheitsmonitor 2015: Bürgerorientierung im Gesundheitswesen - Kooperationsprojekt der Bertelsmann Stiftung und der BARMER GEK. 1. Aufl*. Gütersloh: Verlag Bertelsmann Stiftung (2015) p. 151–72.
44. Richter M, Hurrelmann K (editors.). *Gesundheitliche Ungleichheit*. Wiesbaden: VS Verlag für Sozialwissenschaften (2009). doi: 10.1007/978-3-531-91643-9
45. Kryspin-Exner I, Pintzinger, N. Theorien der Krankheitsprävention und des Gesundheitsverhaltens. In: Hurrelmann K, Klotz T, Haisch J, editors. *Lehrbuch Prävention und Gesundheitsförderung. 3. Aufl*. Bern: Verlag Hans Huber (2010). p. 24–35.
46. Lampert T, Richter M, Schneider S, Spallek J, Dragano N. Soziale Ungleichheit und Gesundheit: Stand und Perspektiven der sozialepidemiologischen Forschung in Deutschland. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz.* (2016) 59:153–65. doi: 10.1007/s00103-015-2275-6
47. Seibt, A. Sozial-kognitives Prozessmodell des Gesundheitsverhaltens. *In*: Leitbegriffe der Gesundheitsförderung und Prävention, Glossar zu Konzepten, Strategien und Methoden, editors. *Bundeszentrale für gesundheitliche Aufklärung (BZgA)*. Gamburg: Verlag für Gesundheitsförderung (2011). p. 521–3.
48. Breuer C, Hallmann K, Wicker P, Feiler S. Socio-economic patterns of sport demand and ageing. *Eur Rev Aging Phys Act.* (2010) 7:61–70. doi: 10.1007/s11556-010-0066-5

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Health, Transport and the Environment: The Impacts of the COVID-19 Lockdown on Air Pollution

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Lockdown measures were initiated in Italy on March 9th after the start of the SARS-CoV-2 epidemic to flatten the epidemic curve. The aim of the present study was to assess the impact of restrictive measures in the Apulia Region, southern Italy, on air quality from March to April 2020. We applied a dual-track approach. We assessed citizen mobility and vehicle traffic with mobility network data and information obtained from satellite tracking, and we evaluated and compared pollutant concentration data as measured by monitoring stations maintained by the Regional Agency for Environmental Protection and Prevention of Apulia (ARPA). The results showed a decrease in the weekly mean NO_2 concentration recorded by urban traffic stations during the lockdown period. In particular, in the city of Bari, the average NO_2 concentration decreased from 62.2 $\mu g/m^3$ in March 2019 to 48.2 $\mu g/m^3$ in March 2020. Regarding PM10 levels, the average concentrations at the individual traffic stations showed no particular variation compared to those in the same months of the previous year, except for Bari-Caldarola Station in March 2019/2020 (p-value < 0.001) and in April 2019/2020 (p-value $= 0.04$). In particular the average in March 2019 was $\sim$26.9 $\mu g/m^3$, while that in March 2020 was $\sim$22.9 $\mu g/m^3$. For April, the average concentration of PM10 in 2019 was 27.9 $\mu g/m^3$, while in 2020, the average was $\sim$22.4 $\mu g/m^3$. This can be explained by the fact that PM10 levels are influenced by multiple variables such as weather and climate conditions and desert dust advections.

Keywords: SARS-CoV-2, COVID-19 lockdown, air pollution, transport, environment

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BACKGROUND

Air pollution has become a growing concern in the past few years because of its effects on public and individual health. Air pollutants, such as particulate matter (PM), ozone, nitrogen oxide, sulfur dioxide, volatile organic compounds, dioxins, polycyclic aromatic hydrocarbons, persistent organic pollutants, carbon monoxide, asbestos and heavy metals are considered risk factors for various diseases (1–12). Long-term exposure to air pollutants is also associated with a variety of cancers (13–17). PM is most closely associated with the increased incidence of lung cancer (18). According to the World Health Organization (WHO) 3 million deaths/year in 2016 were linked to exposure to outdoor air pollution (19).

The Coronavirus Disease 2019 (COVID-19) restriction measures have been mainly oriented on flattening the epidemic curve, but at the same time confinement of the population, reduction of public transport and economic activities let to a considerable decrease in road traffic, and consequently, in levels of urban air pollution.

Italy has been the first European country to be severely affected by COVID-19 (20–22). The first case of COVID-19 was detected on February 20, 2020 in Codogno, near Milan (23) and since then, behavioral, clinical and government interventions have been undertaken to contain the outbreak and prevent the collapse of public health systems (24). On February 23, 2020, the Italian Government declared the area of the outbreak "red zone," limiting social, cultural, economic activities, transports and schools (25). The Decree of the President of the Council of Ministers (March 9, 2020) established that any movement of individuals throughout the national territory was to be avoided. These measures reduced the free movement of citizens, with a large impact on the transportation sector, one of the most affected[1]. By 25 March, everything not related to food provision, pharmacies, health services and basic functioning of the country (the so defined "non-essential activities") had been shut down (26).

Recently, scientists from the Royal Netherlands Meteorological Institute (KNMI) tried to document the effects of the drastic reduction in vehicular traffic on air quality and pollution levels through the analysis of data from Copernicus Sentinel-5P satellite. Nitrogen dioxide (NO_2) was used as the tracer, not only because it is an indicator of the mixture of all pollutants derived from vehicular traffic but also because it responds rapidly to emission variations. From 13 March to 13 April 2020, satellite images showed a decrease in the mean NO_2 concentration across Europe compared to the same months in the previous year. In Italy, these effects were more significant in the Po valley area, although satellite images also showed an important decrease in the NO_2 concentration in the rest of the national territory [2].

The aim of the present study was to assess the impact of the restrictive measures on air quality in the regional territory of Apulia, southern Italy, with a focus on NO_2 and PM10 levels in the municipal area of Bari in the months of March and April 2020.

METHODS

We applied a dual-track approach with assessment of the following:

- Citizen mobility in Italy and monitoring of vehicle traffic during the "lockdown period" (March–May 2020) by comparing mobility network data and information resulting from satellite tracking. From January to April 2020, the Observatory on the Italian Public Accounts compared data provided by digital companies such as Google and Apple. Specifically, data related to driving directions that were available on the website "Mobility Trends Reports" by Apple were compared to Community Mobility Reports by Google, which show changes in visits to places such as grocery stores and parks. From 11 March to 3 May 2020, the National Observatory of Survey on Mobility Style and Behaviors of Italians (AUDIMOB) of the High Institute for Transport Education and Research (ISFORT) carried out a study on the mobility of Italian citizens in the age group of 14–80 years using telephone and online interviews. Data relating to vehicle traffic during the "lockdown period" are available from digital platforms such as the "Mobility Data Lab" and "Enel X City Analytics." The "Mobility Data Lab" is a digital platform available to the community that collects data from millions of vehicles equipped with on-board telematic devices and is able to provide mileage data anonymously. "Enel X City Analytics" is a free mobility map by the Enel X network that, in full compliance with privacy protection standards, allows users to view several data in the selected geographical area: (the percent changes in journeys compared to those on the same day in the previous week and the pre-emergency reference period; the percent changes in average distances traveled compared to those on the same day in the previous week and pre-emergency reference period; input-output flows in the selected geographical area).
- Data resulting from the analysis of pollutant concentrations measured by monitoring stations maintained by the Regional Agency for Environmental Protection and Prevention of Apulia (ARPA) from March-April 2020. In this period ARPA carried out a study to monitor variations in pollutants following the main events that occurred during the lockdown period, such as school closures (Decree of March 4, 2020, issued by the President of the Council of Ministers) and the extension of restrictive travel measures to the whole national territory (Decree of March 9, 2020, issued by the President of the Council of Ministers). For each provincial capital, a monitoring station that was exposed to vehicular traffic was selected. The six identified stations were classified as 4 urban traffic stations (BARI—c.so Cavour, BRINDISI—via dei Mille, LECCE—Piazza Libertini, TARANTO—via Alto Adige) and 2 urban background stations (FOGGIA—via Rosati, BARLETTA—via Casardi). Furthermore, into the city of Bari we considered the 5 monitoring stations in the metropolitan area: 3 traffic stations (Bari-Caldarola, Bari-Cavour, Bari CUS) and 2 urban background stations (Bari Carbonara, Bari Kennedy). The 3 traffic stations record the emissions concentrations of pollutants due to vehicular traffic, while the 2 urban background stations record pollutants concentrations which originate from multiple sources (industries, traffic, residential heating). Consequently, for the aim of our study we only evaluated the data from the 3 traffic stations. All the monitoring stations are part of the network of Air Quality Monitoring Stations (RRQA) managed by local environmental agency (ARPA Puglia). RRQA network consists of samplers/analyzers that detect and analyze the

[1]http://www.protezionecivile.gov.it/documents/20182/1227694/Summary+of+measures+taken+against+the+spread+of+C-19/c16459ad-4e52-4e90-90f3-c6a2b30c17eb

[2]https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Coronavirus_lockdown_leading_to_drop_in_pollution_across_Europe

concentration of air pollutants (SO_2, NOx, CO, O_3, C6HS), and particulate matters continuously (24 h/day) all year round according to reference technical standards (UNI EN 14211:2012 for NO_2 and UNI EN 16450:2017 for PM10) (27, 28). NOx air sampling takes place hourly with TELEDYNE Mod. T200 in Bari-Kennedy station and with TELEDYNE Mod. 200E in the remaining Bari stations. PM10 air sampling takes place daily with ENVIRONMENT Mod. MP101M in Bari-Carbonara station, SWAM FAI INSTRUMENTS Mod. 5A DUAL CHANNEL in Bari-Cavour and Bari-Caldarola stations, SWAM FAI INSTRUMENTS Mod. 5° in Bari-Kennedy and Bari-CUS stations. Quality Assurance/Quality Control (QA/QC) activities are regularly conducted by ARPA Puglia in accordance with Italian law (29) since 2013, at first with the QA/QC of the oxide analyzers of nitrogen (NOx) and ozone (O_3) and afterwards adding the controls on the monoxide analyzers carbon (CO) and the verification of the sampling flows of the particulate analyzers/samplers atmospheric (PM10 and PM2.5).

Statistical analysis was performed with IBM SPSS Statistics Version 26. Kolomorgov-Smirnov and Shapiro-Wilk tests were performed to verify that the variables followed a Gaussian distribution and to choose appropriate statistical tests. It was found that not all variables distribute normally so Wilcoxon's non-parametric method was chosen to compare the means of the variables. P-values < 0.05 were considered statistically significant.

RESULTS

Italian Mobility During the "Lockdown Period"

Data analysis showed that in Italy mobility almost ceased during the lockdown period. In particular, on 13 April, travel to the workplace decreased by more than 60%, and a reduction in the use of public transportation and cars occurred (90 and 85%, respectively) compared to use on 13 January 2020 [3].

AUDIMOB research showed a decrease in the mobility rate "in the strictest sense" (percentage of interview subjects who, during the day, traveled at least once by any mode of transportation, with the exception of walking <5 min) from 85% in 2019 to 32% in the lockdown period. Furthermore, there was a sharp decline in public and exchange mobility (public transportation, combination of modes) from 12.2 to 4.1% during the same period. In contrast, the study noted an increase in the proportion of active mobility from 25.1% in 2019 to 34.9% in 12 March−3 May [4].

Vehicle Traffic During the "Lockdown Period"

"*Mobility Data Lab*" data showed that in Italy, the daily journey (number of vehicles for kilometers) decreased considerably starting in the second half of March, both for heavy vehicles (−38%) and for light vehicles (−71%). In particular, on 12 April 2020, it was recorded the highest reduction in the number of vehicles for kilometers compared to the same day in February (pre-lockdown) for both light vehicles (7,633,011 on 12 January 2020 vs. 430,477 on 12 April 2020; −94.4 %) and for heavy vehicles (2,213,498 of 12 January 2020 vs. 36,301 of 12 April 2020; −98.4%). According to national data, the lowest value in Apulia Region (39,237 vehicles for kilometers) was recorded on 12 April 2020 (approximately a month after the beginning of lockdown) [5].

"*Enel X City Analytics*" data showed that in the Apulia region, the percent changes in the numbers of journeys and kilometers traveled, compared to the standard reference period of 13 January−16 February, reached minimum values of −90 and −92% on 13 April 2020. On 12 April 2020, the maximum variation in input-output flows occurred (−94 and −93%, respectively).

The Analysis of Pollutant Concentrations

The analysis of ARPA data showed that during the lockdown period, a decrease in the weekly mean NO_2 concentration recorded by urban traffic stations occurred. In particular, the Bari – Corso Cavour station recorded a weekly mean NO_2 concentration of 36.57 $\mu g/m^3$ in the fourth week of lockdown (19 March 2020–25 March 2020). In the same week of 2015 this value was 94.71 $\mu g/m^3$, in 2016 was 92.29 $\mu g/m^3$ and in 2017 was 69.43 $\mu g/m^3$. The same traffic station recorded a weekly mean NO_2 concentration of 29.43 $\mu g/m^3$ in the fifth week of lockdown (26 March 2020–01 April 2020). In the same week of 2015 this value was 96.43 $\mu g/m^3$, in 2016 was 76.71 $\mu g/m^3$ and in 2017 was 69.14 $\mu g/m^3$.

At each monitoring station, data for each day were recorded during both the pre-emergency and lockdown periods. In all cases, a decrease in the mean NO_2 concentration was evident, especially during peak hours.

Regarding particulate matter, the relationships between PM10 and PM2.5 concentration reductions and emergency restrictions were unclear. The particulate matter concentration is influenced by different factors, such as weather conditions (e.g., sand from desert areas). Indeed, during the last days of March, despite restrictive measures, the monitoring stations recorded levels exceeding the daily legal limit for PM10; this was presumably connected to the occurrence of desert dust from the Caspian Sea [6].

Air Quality in the Municipal Area of Bari in 2019 vs. 2020

On the website http://www.arpa.puglia.it/web/guest/meta-aria, all environmental monitoring data resulting from the ARPA stations are available. An analysis of NO_2 data collected during the lockdown period revealed variations in the average concentrations at the traffic stations in the months of March and April 2020 compared with those in the previous year.

[3]https://osservatoriocpi.unicatt.it/cpi-Lockdown%20e%20mobilit%C3%A0.pdf
[4]https://www.isfort.it/wp-content/uploads/2020/06/200521_Isfort_MobilitaItaliani_Lockdown_DEF.pdf
[5]https://lab.octotelematics.com/
[6]https://www.snpambiente.it/2020/04/08/qualita-dellaria-in-puglia-in-concomitanza-dellemergenza-covid-19/

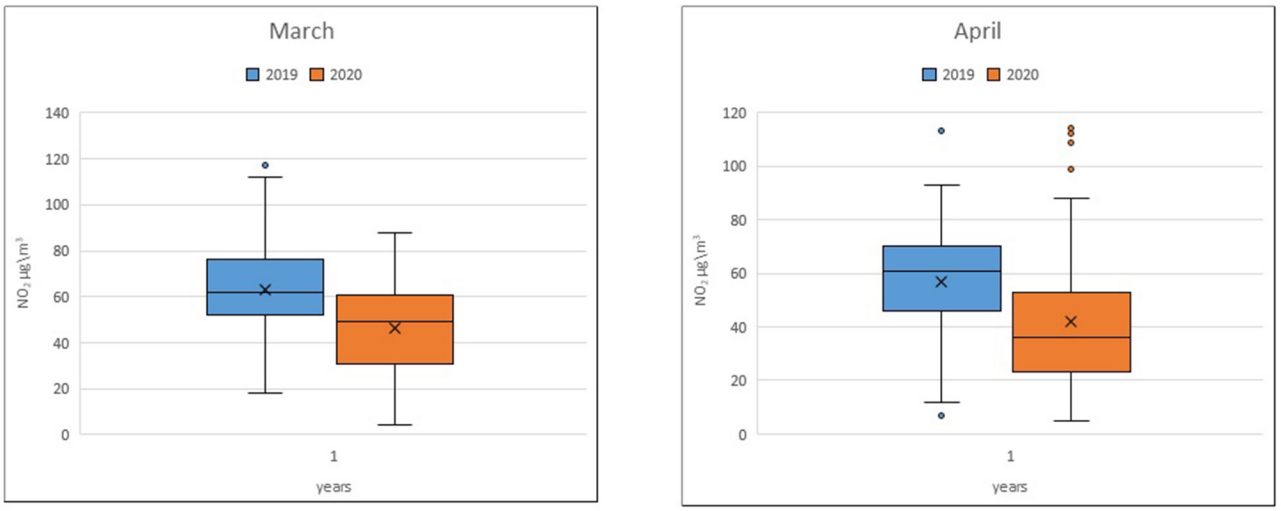

FIGURE 1 | NO_2 monthly average at the traffic stations.

The average in March 2019 was ∼62.2 $\mu g/m^3$, while that in March 2020 was ∼48.2 $\mu g/m^3$. For April, the average in 2019 was 56.6 $\mu g/m^3$, while in 2020, the average was ∼42.16 $\mu g/m^3$ (**Figure 1**).

Notable reductions in the average NO_2 concentrations at single traffic stations in March and April 2020 compared to those in the previous year are evident. In particular, the statistical analysis showed significant differences in the NO_2 concentration in March 2019/2020 for the Bari-Cavour monitoring station ($p < 0.001$) and in April 2019/2020 for the Bari-Caldarola ($p = 0.033$) and Bari-Cavour stations ($p < 0.001$) (**Table 1**).

Regarding PM10 levels, the average in March 2019 was ∼26.9 $\mu g/m^3$, while that in March 2020 was ∼22.9 $\mu g/m^3$. For April, the average concentration of PM10 in 2019 was 27.9 $\mu g/m^3$, while in 2020, the average was ∼22.4 $\mu g/m^3$ (**Figure 2**).

The average concentrations of PM10 at the individual traffic stations in the months of March and April 2020 showed no particular variation compared to those in the same months of the previous year, except for Bari-Caldarola Station in March 2019/2020 (p-value < 0.001) and in April 2019/2020 (p-value $= 0.04$) (**Table 2**). This result is in contrast with the clear reduction in emissions from vehicular traffic during the lockdown phase and is likely attributable to the influence of weather conditions on particulate concentrations.

DISCUSSION AND CONCLUSION

This is the first assessment of the effects of restrictive measures in the Apulia region on air pollution during the national lockdown period in Italy. These adopted mobility measures have seriously weakened the national socioeconomic balance; however, the significant impact on travel and the consequent reduction in pollutant emissions from transportation has had a positive effect on air quality.

Vehicular transportation is the sector that experienced the greatest impact due to the drastic and significant decline in mobility during the period of restriction. The transportation sector has a major impact on the national emissions budget. Pollutants, such as atmospheric particulate matter (PM10, PM2.5) and nitrogen dioxide (NO_2), whose levels are closely related to patterns of vehicular traffic, generally reach high concentrations in urban areas. In the latest "Italian Emission Inventory 1990–2018" report, The Higher Institute for Environmental Protection and Research (ISPRA) notes that this sector is responsible for 43.5% of the total emissions of nitrogen oxides, 19.9% of carbon monoxide, 11.9% of NMVOCs (Non-methane Volatile Organic Compounds) and 11.8 and 10.5% of total PM10 and PM2.5, respectively (30). At the regional level, according to the latest "Regional Inventory of Emissions into the Atmosphere - INEMAR Puglia," road transportation is the main emission source of nitrogen oxides, accounting for 42.5% of total annual emissions. Regarding dust, road transportation is responsible for 18.4 and 18.5% of PM10 and PM2.5 total emissions/year, respectively (31).

In the Apulian region, data collected by the monitoring stations maintained by the Regional Environmental Protection Agencies (ARPA) in March–April 2020 showed that the daily concentrations of air pollutants such as NO_2 (a primary pollutant directly produced by vehicular emissions) were reduced at all the selected monitoring stations. In particular, in the municipal area of Bari, the statistical analysis showed significant differences in the average NO_2 concentration in March 2019/2020 for the Bari-Cavour monitoring station ($p < 0.001$) and in April 2019/2020 for the Bari-Caldarola ($p = 0.033$) and Bari-Cavour stations ($p < 0.001$). On the contrary the monthly average PM10 concentration showed no significant difference between March–April 2019 and the same months in 2020 except for Bari-Caldarola station[6]. Different authors have reported improvements in air quality after the lockdown period in several countries, especially in

TABLE 1 | NO_2 March-April 2019/2020 concentrations.

NO_2	Bari-Caldarola station μg/m³				Bari-Cavour station μg/m³				Bari-CUS station μg/m³			
	Average	Min-max	SD	*p*-value	Average	Min-max	SD	*p*-value	Average	Min-max	SD	*p*-value
March 2019	65.9	50–94	12.87	0.569	72.3	43–117	19.37	<0.001	48.5	18–84	17.82	0.465
March 2020	59.1	23–84	18.17		45.2	12–75	17.47		40.3	4–88	24.38	
April 2019	63.4	39–89	10.71	0.033	72.3	47–113	15.45	<0.001	34.0	7–56	13.43	0.071
April 2020	49.2	13–114	34.21		38.3	18–73	15.20		38.0	5–99	22.63	

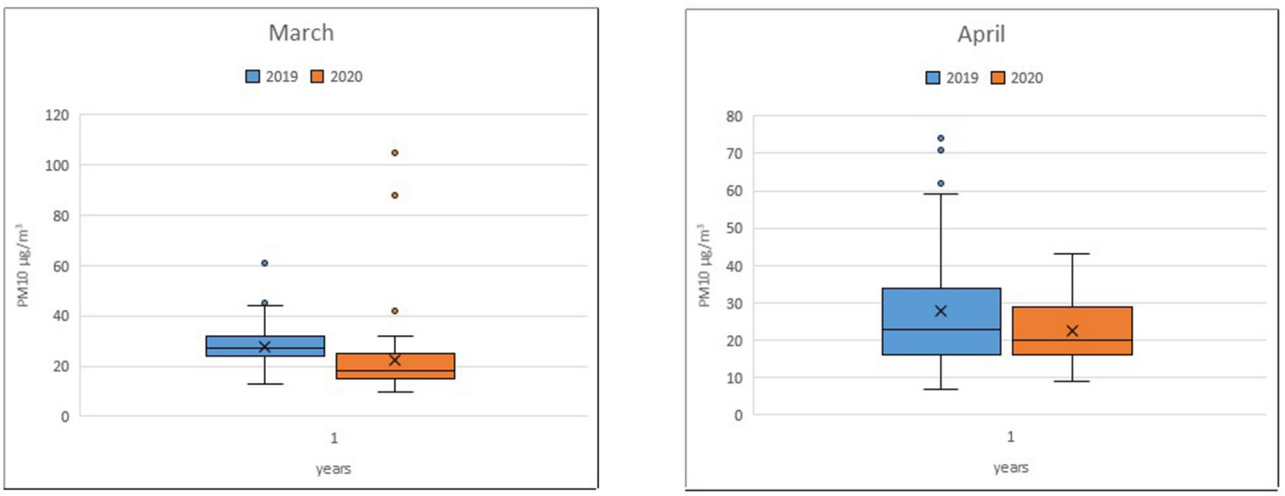

FIGURE 2 | Traffic station PM10 monthly average.

places that had relatively high levels of air pollutants before the pandemic period (for example, Brazil, China, and India) (32). In accordance with our data, a Spanish study observed that after 2 weeks of lockdown in the city of Barcelona, NO_2 was reduced by half, while there was a lower reduction in the PM10 concentration (33). The same result was reported by Otmani et al. in a study conducted in Salé City (Morocco); PM10, NO_2, and SO_2 concentrations were reduced by more than half during the COVID-19 lockdown period, but the most significant variation was observed for NO_2 (34). Mahata et al. obtained different results in a study on air quality of the megacity Delhi; the study evaluated seven pollutants (PM10, PM2.5, SO_2, NO_2, CO, O_3, and NH_3) at 34 monitoring stations spread throughout the megacity. Among the measured pollutants, PM10 and PM2.5 concentrations were reduced by approximately half compared to those during the pre-lockdown period, while there was a lower reduction in other pollutants, such as NO_2, CO, and NH_3 (35). In contrast to other studies demonstrating that air quality improved during the COVID-19 pandemic, air quality research conducted in New York City revealed no significant change in air quality compared to that during the same periods in 2015–2019. The different results obtained in that study may be explained by the fact that New York City has lower baseline concentrations of air pollutants than other countries that were studied (36).

The preliminary data suggest that the epidemiological emergency attributable to SARS-CoV-2 has radically changed citizen mobility in Italy, particularly affecting the transportation of freight and persons and the free movement of individuals. However, this historical event, albeit dramatic in some respects, has resulted in a significant improvement in air quality.

However, there are still questions about the proportion of the abatement of pollution directly related to the lockdown without meteorological interference, and why PM10 levels were not reduced as much as NO_2 levels. Meteorological conditions have an important influence on the formation of air pollution and changes in pollutant concentration. Among these, temperature and wind speed are generally considered to be two major factors affecting the concentration of air pollutants. (37). Based on the real-time data of several air pollutant concentrations (PM2.5, PM10, CO, SO_2, NO_2, and O_3) and daily meteorological data from June 2014 to February 2019, a recent study by Yansui Liu investigates the spatio-temporal characteristics of air pollutant concentration and meteorological factors in China. Except for O_3, the concentration of other air pollutants at most sites was significantly and negatively correlated with average wind speed, precipitation and relative humidity, but positively correlated with atmospheric pressure. Moreover, the degree of impact depended on the type of pollutants and the geographical location of the

TABLE 2 | PM10 March-April 2019/2020 concentrations.

PM10	Bari-Caldarola station μg/m³				Bari-Cavour station μg/m³				Bari-Cus station μg/m³			
	Average	Min-max	SD	*p*-value	Average	Min-max	SD	*p*-value	Average	Min-max	SD	*p*-value
March 2019	30.1	13–61	9.44	<0.001	25.7	14–38	5.62	0.138	25.0	10–38	6.78	0.374
March 2020	18.4	10–31	5.68		25.9	11–105	20.98		24.4	8–104	21.45	
April 2019	29.9	9–71	16.93	0.04	27.6	11–72	14.80	0.596	26.2	7–24	16.23	0.75
April 2020	20.6	9–35	7.58		23.7	10–41	8.89		22.8	9–43	9.16	

stations. In the North Plain, temperature was recognized as the dominant factor affecting PM10 concentration, while wind speed and relative humidity as the dominant factors in Northeast. Relative humidity was identified as the dominant factor for PM10 concentration changes at most sites. For NO_2, in addition to temperature, atmospheric pressure has also been identified as one of the leading meteorological factors for changes in pollutant concentration in the eastern coastal and northeastern regions. Relative humidity also had a significant impact on NO_2 concentration in the Beijing-Tianjin-Hebei region (38). These results are consistent with previous studies (39, 40). The role of meteorological variables is not quantified: this is a limitation of our study. PM10 concentration levels in urban environment are also influenced by long range transport form remote source areas. In this regard on March 30, 2020, despite restrictive measures, Bari-Cavour and Bari CUS traffic stations recorded levels exceeding the daily legal limit for PM10 (105 and 104 μg/m^3). This was probably connected to a rare advection of non-anthropogenic fine dust, carried by current from the East. Modeling simulations, performed by ARPA agencies as part of the new SNPA-ASI Copernicus platform, showed that it was dust from the Asian desert, bordering the Caspian Sea. The natural origin of PM is further demonstrated by the fact that in the last days of March 2020 there was a very significant increase in PM10, but not in PM2.5, suggesting that the dust of these days are coarse, compatible with a terrigenous origin[6].

In Italy, the legislative and technological measures implemented in recent years have produced environmental benefits, such as the introduction of new air quality standards, regulation of the use of fuels, and establishment of a number of monitoring stations for pollutants. However, the need to maintain restrictive measures during the post-emergence phase could affect the current sustainable mobility policies. Interpersonal distancing and compliance with hygiene standards could encourage the use of private vehicles, discourage the use of public transportation and compromise all progress on sustainable mobility.

Therefore, it would be desirable to implement the following strategies[7]:

- Redistribute the demand for mobility, for example, by expanding and diversifying the start times of workplaces, public offices, schools, and shopping centers;
- Reduce the demand for mobility, for example, by encouraging teleworking;
- Promote shared mobility solutions, such as bike sharing, scooter sharing and electric micromobility;
- Encourage the building of pedestrian and cycling infrastructure, such as bike lines;
- Redesign urban spaces according to proximity criteria. In this regard, the French urban regeneration project called *"La ville du quart d'heure"* is exemplary. In this project, each district of the city will be provided a number of useful services for everyday life (e.g., grocery stores, green areas, healthcare facilities) that are accessible by foot or by bicycle with a maximum 15-min travel time.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

LV: project administration. ST, NM, CL, and LV: conceptualization, supervision, and project administration. LD, AC, and EC: writing—original draft preparation, review, and editing. SS and MD: data curation. AP: formal analysis. VB and LA: investigation. All authors have read and agreed to the published version of the manuscript.

[7]https://www.kyotoclub.org/medialibrary/Rapporto_Mobilitaria2020_DEFINITIVO_maggio2020.pdf

REFERENCES

1. Manisalidis I, Stavropoulou E, Stavropoulos A, Bezirtzoglou E. Environmental and health impacts of air pollution: a review. *Front Public Health.* (2020) 8:14. doi: 10.3389/fpubh.2020.00014
2. Goddard SL, Williams KR, Robins C, Butterfield DM, Brown RJC. Concentration trends of metals in ambient air in the UK: a review. *Environ Monit Assess.* (2019) 191:683. doi: 10.1007/s10661-019-7824-2
3. Socorro J, Durand A, Temime-Roussel B, Gligorovski S, Wortham H, Quivet E. The persistence of pesticides in atmospheric particulate phase:

an emerging air quality issue. *Sci Rep.* (2016) 6:33456. doi: 10.1038/srep 33456
4. Vimercati L, Baldassarre A, Gatti MF, Gagliardi T, Serinelli M, De Maria L, et al. Non-occupational exposure to heavy metals of the residents of an industrial area and biomonitoring. *Environ Monit Assess.* (2016) 188:673. doi: 10.1007/s10661-016-5693-5
5. Vimercati L, Gatti MF, Gagliardi T, Cuccaro F, De Maria L, Caputi A, et al. Environmental exposure to arsenic and chromium in an industrial area. *Environ Sci Pollut Res Int.* (2017) 24:11528–35. doi: 10.1007/s11356-017-8827-6
6. Campo L, Vimercati L, Carrus A, Bisceglia L, Pesatori AC, Bertazzi PA, et al. Environmental and biological monitoring of PAHs exposure in coke-oven workers at the taranto plant compared to two groups from the general population of Apulia, Italy. *Medicina Del Lavoro.* (2012) 103:347–60.
7. Vimercati L, Cavone D, Lovreglio P, De Maria L, Caputi A, Ferri GM, et al. Environmental asbestos exposure and mesothelioma cases in Bari Apulia region southern Italy a national interest site for land reclamation. *Environ Sci Pollut Res.* (2018) 25:15692–701. doi: 10.1007/s11356-018-1618-x
8. Quarato M, De Maria L, Gatti MF, Caputi A, Mansi F, Lorusso P, et al. Air pollution and public health: a PRISMA-compliant systematic review. *Atmosphere.* (2017) 8:183. doi: 10.3390/atmos8100183
9. Vimercati L, Baldassarre A, Gatti MF, De Maria L, Caputi A, Dirodi AA, et al. Respiratory health in waste collection and disposal workers. *Int J Environ Res Public Health.* (2016) 13:631. doi: 10.3390/ijerph13070631
10. Vimercati L, Gatti MF, Baldassarre A, Nettis E, Favia N, Palma M, et al. occupational exposure to urban air pollution and allergic diseases. *Int J Environ Res Public Health.* (2015) 12:12977–87. doi: 10.3390/ijerph121012977
11. Vimercati L, Carrus A, Bisceglia L, Tat I, Bellotta M.R, Russo A, et al. Biological monitoring and allergic sensitization in traffic police officers exposed to urban air pollution. *Int J Immunopathol Pharmacol.* (2006) 19:57–60.
12. Vimercati L. Traffic related air pollution and respiratory morbidity. *Lung India.* (2011) 28:238. doi: 10.4103/0970-2113.85682
13. Vimercati L, Cavone D, Caputi A, Delfino MC, De Maria L, Ferri GM, et al. Malignant mesothelioma in construction workers: the Apulia regional mesothelioma register, Southern Italy. *BMC Res Notes.* (2019) 12:636. doi: 10.1186/s13104-019-4675-4
14. Serio G, Vimercati L, Pennella A, Gentile M, Cavone D, Buonadonna AL, et al. Genomic changes of chromosomes 8p23.1 and 1q21: novel mutations in malignant mesothelioma. *Lung Cancer.* (2018) 126:106–11. doi: 10.1016/j.lungcan.2018.10.012
15. Nakano T, Otsuki T. Environmental air pollutants and the risk of cancer. *Gan To Kagaku Ryoho.* (2013) 40:1441–5.
16. Kim HB, Shim JY, Park B, Lee YJ. Long-term exposure to air pollutants and cancer mortality: a meta-analysis of cohort studies. *Int J Environ Res Public Health.* (2018) 15:2608. doi: 10.3390/ijerph15112608
17. Cavone D, Caputi A, De Maria L, Cannone ESS, Mansi F, Birtolo F, et al. Epidemiology of mesothelioma. *Environments.* (2019) 6:76. doi: 10.3390/environments6070076
18. IARC. *IARC* Monographs on the evaluation of carcinogenic risks to humans. Vol. 109. In: *Outdoor air Pollution*. Lyon: International Agency for Research on Cancer.
19. World Health Organization. *Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease*. World Health Organization (?2016)?.
20. Phan LT, Nguyen TV, Luong QC, Nguyen TV, Nguyen HT, Le HQ, et al. Importation and human-to-human transmission of a novel coronavirus in vietnam. *NEJM.* (2020) 382:872–4. doi: 10.1056/NEJMc2001272
21. Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, et al. First case of 2019 novel coronavirus in the United States. *N Engl J Med.* (2020) 382:929–36. doi: 10.1056/NEJMoa2001191
22. Giovanetti M, Benvenuto D, Angeletti S, Ciccozzi M. The first two cases of 2019-nCoV in Italy: where they come from? *J Med Virol.* (2020) 92:518–21. doi: 10.1002/jmv.25699
23. Grasselli G, Pesenti A, Cecconi M. Critical care utilization for the COVID 19 outbreak in Lombardy, Italy. *JAMA.* (2020) 323:1545–6. doi: 10.1001/jama.2020.4031
24. Spinazzè A, Cattaneo A, Cavallo DM. COVID-19 outbreak in Italy: protecting worker health and the response of the Italian industrial hygienists association. *Ann Work Exposures Health.* (2020) 64:559–64. doi: 10.1093/annweh/wxaa044
25. IMH. *Ordinance February, 23 2020 – Urgent Measures for the Containment and Management of the Epidemiological Emergency from COVID19*. Lombardy Region. Italian Ministry of Health, Milan and Rome (2020).
26. WHO. *An Unprecedented Challenge - Italy's First Response to COVID-19.* World Health Organization, Regional Office for Europe (2020).
27. UNI EN 14211:2012. *Ambient Air - Standard Method for the Measurement of the Concentration of Nitrogen Dioxide and Nitrogen Monoxide by Chemiluminescence* (2012).
28. UNI EN 16450:2017. *Ambient Air - Automated Measuring Systems for the Measurement of the Concentration of Particulate Matter (PM10; PM2,5)* (2017).
29. *Italian Legislative Decree n.155 13 August 2010* (2010).
30. Higher Institute for Environmental Protection and Research (ISPRA). *Italian Emission Inventory 1990-2018. Informative Inventory Report 2020.* Higher Institute for Environmental Protection and Research (2020).
31. *Regional Inventory of Emissions into the Atmosphere - INEMAR Puglia* (2014).
32. IQAir IQAir. *REPORT: COVID-19 Impact on Air Quality in 10 Major Cities.* IQAir (2020). Available online at: https://www.iqair.com/blog/air-quality/report-impact-of-covid-19-on-global-air-quality-earth-day (accessed February 25, 2020).
33. Tobías A, Carnerero C, Reche C, Massagué J, Via M, Minguillón MC, et al. Changes in air quality during the lockdown in Barcelona (Spain) one month into the SARS-CoV-2 epidemic. *Sci Total Environ.* (2020) 726:138540. doi: 10.1016/j.scitotenv.2020.138540
34. Otmani A, Benchrif A, Tahri M, Bounakhla M, Chakir EM, El Bouch M, et al. Impact of Covid-19 lockdown on PM10, SO_2 and NO_2 concentrations in Salé City (Morocco). *Sci Total Environ.* (2020) 735:139541. doi: 10.1016/j.scitotenv.2020.139541
35. Mahato S, Pal S, Ghosh KG. Effect of lockdown amid COVID-19 pandemic on air quality of the megacity Delhi, India. *Sci Total Environ.* (2020) 730:139086. doi: 10.1016/j.scitotenv.2020.139086
36. Zangari S, Hill DT, Charette AT, Mirowsky JE. Air quality changes in New York City during the COVID-19 pandemic. *Sci Total Environ.* (2020) 742:140496. doi: 10.1016/j.scitotenv.2020.140496
37. Li R, Wang Z, Cui L, Fu H, Zhang L, Kong L, et al. Air pollution characteristics in China during 2015–2016: spatiotemporal variations and key meteorological factors. *Sci Total Environ.* (2019) 648:902–15. doi: 10.1016/j.scitotenv.2018.08.181
38. Liu Y, Zhou Y, Lu J. Exploring the relationship between air pollution and meteorological conditions in China under environmental governance. *Sci Rep.* (2020) 10:14518. doi: 10.1038/s41598-020-71338-7
39. Liu C, Chen R, Sera F, Vicedo-Cabrera AM, Guo Y, Tong S, et al. Ambient particulate air pollution and daily mortality in 652 cities. *New Eng J Med.* (2019) 381:705–15. doi: 10.1056/NEJMc1913285
40. He J, Gong S, Yu Y, Yu L, Wu L, Mao H, et al. Air pollution characteristics and their relation to meteorological conditions during 2014–2015 in major Chinese cities. *Environ Pollut.* (2017) 223:484–96. doi: 10.1016/j.envpol.2017.01.050

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Health and Well-Being of Athletes During the Coronavirus Pandemic: A Scoping Review

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Background: The ongoing global pandemic has become the world's leading health problem, causing massive public fear and concern. Reports suggest that athletes are seeking mental health support, showing the pressures of boredom, and tension associated with their anticipated social isolation. The current study seeks to evaluate the evidence regarding the effects of the coronavirus pandemic on occupational stress in professional athletes.

Method: A scoping review was conducted. A comprehensive search involving Embase and PubMed databases was conducted using a combination of the following key words: COVID-19, SARS-CoV-2, coronavirus, and athletes. In this study, articles were retained if they were original studies reporting on the impact of the pandemic on professional athletes.

Results: Nine studies were identified as they investigated the impact of the pandemic on athletes. Most were observational and cross-sectional, and one was longitudinal. Outcome measures mainly investigated were level of depression, anxiety, and stress. Dependent variables were physical activity, nutrition, mental state, sleep quality, individual well-being, social identity, exclusivity, negative affectivity, alcohol consumption, psychological distress, and gambling habits.

Conclusions: This review highlights the need for proactive engagement with professional athletes, coaches, trainers, and sports councils to facilitate understanding and awareness-raising, process optimization, and delivery of consistent training and psychosocial aid and occupational therapy programs that maintain the health and well-being of athletes while minimizing occupational stress during a pandemic.

Keywords: COVID-19, SARS-CoV-2, coronavirus, athletes, psychosocial, occupational stress, primary health care

INTRODUCTION

The coronavirus pandemic in 2020 resulted in significant global challenges. Government agencies and public health organizations have adopted public health initiatives to minimize the peak infection rate, of which the most effective recommendation known to restrict and postpone the spread of the virus is social (physical) distancing. Most countries have increasingly adopted community isolation measures to increase social distancing, such as mandatory lockdowns, isolation periods, and the closing of public areas (1). Studies investigating the impact of the coronavirus pandemic on public health have found a high level of psychological distress due to lockdown, fear of infection, and adjusting to new protective measures (2).

Social distancing measures have resulted to a substantial rise in workplace stress, with many categories of workers affected (3). Work-related factors may play a crucial role in exacerbating the effects of the pandemic isolation measures on people's mental well-being. Healthcare workers, especially those on the frontline, migrant workers, and workers in contact with the public are among the most affected with psychological critical issues in the workplace (3–5). Job insecurity and future uncertainty are significantly contributing to this "psychological pandemic" (3).

The world of sports has not been exempted from the protective measures against pandemic, with athletes unable to practice or compete or participate in international competitions. Global health recommendations have led to the cancellations and postponements of numerous athletic events in order to social distance and in an attempt to limit the spread of the virus (6). International sporting events, such as the Olympic Games, Euro (European Football Championships), and the Wimbledon Tennis Tournament, were either postponed or finally canceled in 2020. In addition to adjusting to the new norms due to the pandemic, athletes in particular have undergone significant lifestyle and routine changes, interpersonal relationships, financial challenges (e.g., work loss or sponsorship), and loss of goals and satisfaction (7). Shortly after the outbreak of the coronavirus pandemic, the International Society for Sport Psychology (ISSP) released three editorials and comments on the effect of the coronavirus pandemic on athletes on the complexities and suggestions of working with athletes (8), sports psychology services (9), and tips for athletes, coaches, parents, and the sports community (10).

With limitations to practice in competitions, the potential implications to athletes are numerous, as this may affect their health with lack of training and their income as matches are canceled. In addition, there may be an element of fear of athletes catching the virus, as there have been numerous high-profile cases of professional athletes testing positive for COVID-19 (11). The fact that high-profile cases have been found positive for the disease, including professional footballers and athletes, despite their recognized high fitness levels indicates that they have not been made less vulnerable to the virus. Fear of catching this virus can lead to stress and adverse effects on the mental health of athletes during this pandemic. While everyone reacts differently to stress, and some athletes may be able to find successful coping mechanisms, other athletes may have a more pessimistic response over the uncertain period of the global pandemic that we are facing. Although anxiety is a natural response to COVID-19 and the effects it has had globally, stressors can be especially harmful to professional athletes as they can fully alter their day-to-day lives. Last but not least, athletes who have not been training due to a pandemic lockdown for some time may worry that this may have a negative effect on their sporting skills and performance. As high levels of stress can have a detrimental impact on everyday life and mental and physical health, there is a need to examine and diagnose psychological problems and deteriorating mental health among professional athletes during the COVID-19 pandemic.

The current study seeks to evaluate the evidence regarding the effects of the coronavirus pandemic on occupational stress in professional athletes.

Abbreviations: DASS-21, Depression-Anxiety-Stress Scale-21; IES-R, Impact of Events Scale-Revised; IPAQ-SF, International Physical Activity Questionnaire Short Form; AIMS, Athletic Identity Measurement Scale; CERQ, Cognitive Emotion Regulation Questionnaire; GAD-7, General Anxiety Disorder-7 Item; PHQ-9, Patient Health Questionnaire-9 Item; PFABS, Hospital for Special Surgery Pediatric Functional Activity Brief Scale; PedsQL, Pediatric Quality of Life Inventory 4.0; AIMS, Athletic Identity Measurement Scale; SSB, Socially Supportive Behaviors; MHC-SF, Mental Health Continuum Short Form instrument; PROMIS, Patient-Reported Outcomes Measurement Information System; POMS, Profile of Mood States, Spanish validated version; WLEIS-S, Wong Law Emotional Intelligence Scale Short form, Spanish validated version; BRS-II, Brief Resilience Scale, Spanish validated version.

METHODS

The scoping review was conducted according to the standards and guidelines established in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) with the associated extension for Scoping Reviews (12).

Search Strategy

We conducted a systematic literature search of the Embase and PubMed databases using a combination of the following keywords: COVID-19, SARS-CoV-2, and athletes. Databases have been checked until the date of our literature searches (30 November 2020). Studies were included in this review if they were original studies focusing on the effect of the pandemic on professional athletes. In order to ensure completeness, we also checked for references to our full-text articles. References of the reported relevant reviews were also screened.

Criteria for eligibility were (1) Population: professional athletes, (2) Intervention: COVID-19 pandemic, (3) Comparator: not available, and (4) Outcomes: any qualitative or quantitative findings published in the literature related to psychological health. No restrictions were placed on study design, age, or injury type.

Exclusion criteria were studies not related to the COVID-19 pandemic, not reporting outcomes, and not in English.

Study Selection

Three reviewers (RH, MA, DH) engaged in the database screening process and the analysis of the full text for eligibility. Disagreements between the three reviewers were

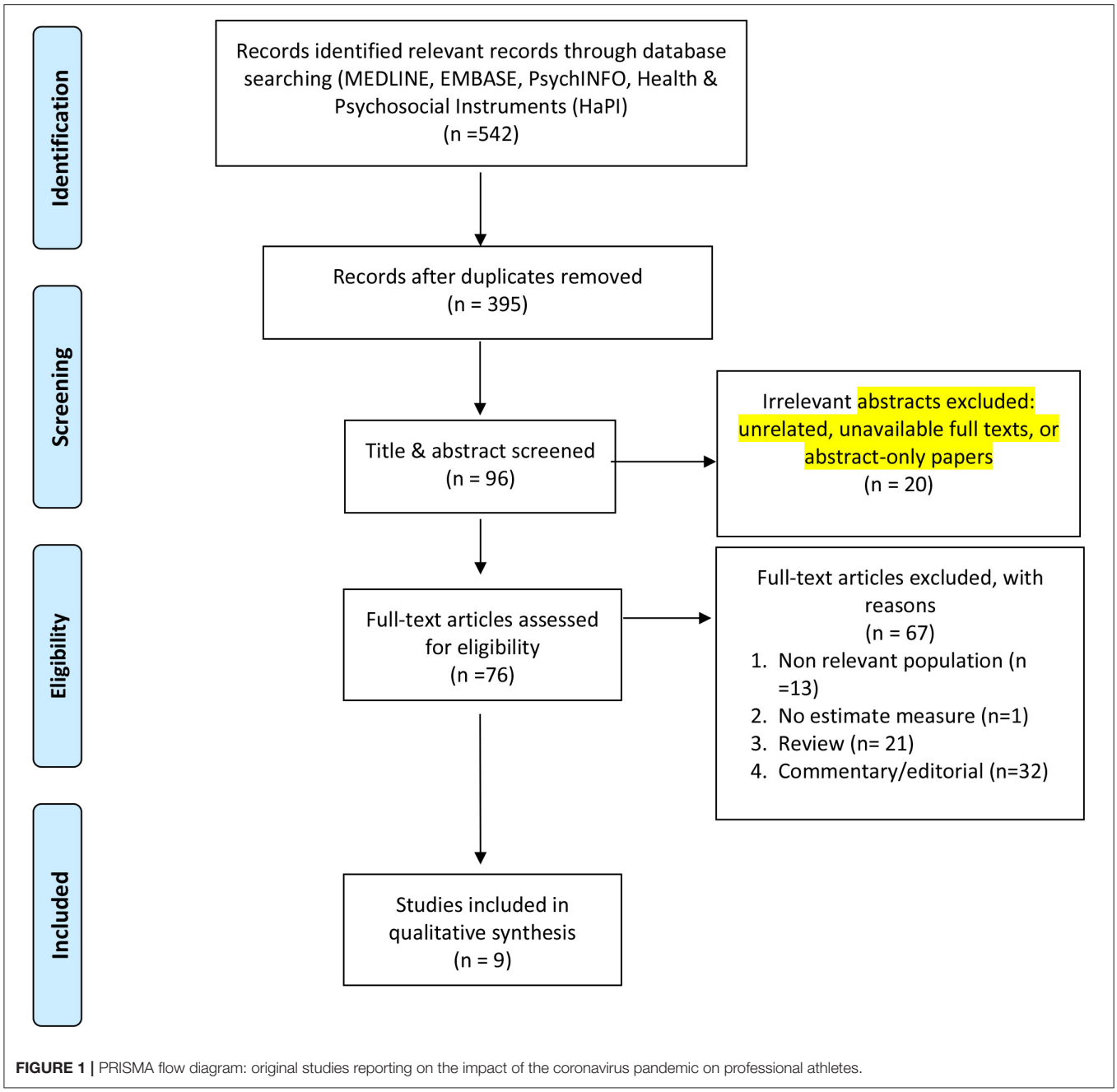

FIGURE 1 | PRISMA flow diagram: original studies reporting on the impact of the coronavirus pandemic on professional athletes.

resolved through dialogue and consultation with the two senior authors (LAC, OCB).

Quality Appraisal

In line with scoping review practice, included studies have not been assessed in terms of quality (13).

RESULTS

The results of the screening process are shown in the PRISMA diagram in **Figure 1**. Of the 542 titles and database citations imported, 395 remained after duplicates had been deleted. After title and abstract screening, 96 were suitable for full text evaluation. Of the 96 deemed suitable, 20 were excluded as unrelated, having unavailable full texts, or being abstract-only papers. Of the 76 full-text articles, a total of nine met the inclusion criteria for this scoping review.

Original research articles were cross-sectional studies (**Table 1**). No conflict of interest has been reported in all studies.

In a 2-month prospective longitudinal study at the German professional men's soccer league, coronavirus infection rate could be kept low through strict hygiene measures including regular PCR testing (14).

TABLE 1 | Original studies reporting on the impact of the pandemic on professional athletes.

	Research design	Participants	Target variables	Main findings
Meyer et al. (14)	2-month prospective longitudinal cohort	1,702 male professional football players from German leagues and the officials working closely with them	(1) Onset of typical COVID-19 symptoms, (2) Positive PCR results, and (3) IgG seroconversion against SARS-CoV-2	Of the 1,702 regularly tested individuals, only eight players and four officials tested positive during one of the first rounds of PCR testing prior to the onset of team training, two players during the third round. No further positive results occurred during the remainder of the season.
Pillay et al. (15)	Cross-sectional survey	692 (67% males) athletes from South Africa	(1) Activity (2) Nutrition (3) Mental state	COVID-19 had physical, nutritional, and psychological consequences
Senişik et al. (16)	Cross-sectional survey	418 athletes of 612 volunteers from Turkey	(1) Mental health: depression and anxiety (DASS-21) and posttraumatic stress levels (IES-R) (2) Physical activity (IPAQ-SF)	Mental health status of athletes was better than the non-athlete controls. Depression levels were similar in team and individual athletes. Team athletes had a lower level of anxiety compared to individual athletes.
Costa et al. (17)	Cross-sectional survey	1,125 (45.8% men) athletes from various sports in Italy	(1) Athletic identity (AIMS scale) (2) Cognitive emotion regulation (CERQ scale)	Athletes with higher athletic identity tend to ruminate and catastrophize more.
Håkansson et al. (18)	Cross-sectional survey	1,145 (82% men) athletes in top leagues of soccer, ice hockey, and handball in Sweden	(1) Depression (2) Anxiety (3) Alcohol drinking (4) Gambling behavior (5) Problem gambling	Distress from pandemic is common in elite athletes and associated with mental health symptoms. Gambling increase during the pandemic was rare, but related to gambling problems.
McGuine et al. (19)	Cross-sectional survey	13,002 (53.1% women) USA adolescent athletes	(1) Physical activity (PFABS) (2) Anxiety (GAD-7) (3) Depression (PHQ-9) (4) Health-related quality of life (PedsQL)	Women reported a higher prevalence of moderate to severe anxiety symptoms. The prevalence of depression symptoms was highest in team sports than individual sports. The total PedsQL score was lowest (worst) for athletes from counties with the highest poverty levels.
Graupensperger et al. (20)	Longitudinal survey, before and after 1 month after university campus closures during COVID-19	234 (63% female) USA student-athletes	(1) Athletic identity change (AIMS) (2) Teammate social support (SSB) (3) Teammate social connectedness (4) Well-being (MHC-SF) (5) Depression (PROMIS) (6) COVID-specific worries	Positive correlations occurred between teammate social experiences and identity maintenance, and consequently, identity maintenance was positively correlated with psychological and social well-being and was negatively associated with depressive symptoms.
Mon-López et al. (21)	Cross-sectional survey, retrospective	187 (64.7% men) handball players from Spain	(1) Demographic variables: gender, age place of residence, number of days confined, sport level, playing position and personal experience with COVID-19 (2) Training variables: training days, training hours, intensity, and recovery. (3) Psychological variables: emotional intelligence (WLEIS-S), mood state (POMS), and resilience (BRS-II)	COVID-19 isolation had significant negative effects on the training and recovery of the athletes, as well as sleep quality, and other psychological variables.
Grazioli et al. (22)	Cross-sectional observational, after 63 days of quarantine and compared with retrospective data obtained after a regular 24-day off-season period	23 male Brazilian professional soccer players who returned to training activities after 63 days of quarantine	(1) Body composition (2) Jump and sprint performance (3) Hamstring eccentric strength (4) Intermittent cardiorespiratory fitness	Quarantine caused a substantial increase in body mass, body fat mass, 10- and 20-m sprint times, and a decrease in counter-movement jump height.

In South Africa, a cohort of elite and semi-elite athletes out of 15 sports reported self-reported pandemic psychological effects on physical, nutritional, and psychological health (soccer, hockey, rugby, cricket, athletics, netball, basketball, endurance running, cycling, track and field, swimming, squash, golf, tennis, karate) (15).

In Turkey, depression and anxiety symptoms were lower in athletes compared to non-athletes but were comparable in team athletes and individual athletes (16).

In Italy, professional athletes and team sports athletes demonstrated a higher athletic identity during the lockdown era (17). Cognitive emotion regulation strategies were different for gender and competitive levels. At the end of the day, athletes with a higher athletic identity appeared to ruminate and catastrophize more.

In Sweden, self-reported pandemic psychological influences have been widespread among elite soccer, ice hockey, and handball athletes, as well as worries about one's sport and one's own career linked to the crisis situation. Depression and anxiety were not significantly higher than predicted but correlated with coronavirus-related worry definitions. Fear of increased gambling during the crisis could not be explicitly shown, but at-risk gambling in male athletes was widespread and also related to a rise in pandemic gambling.

In the USA, during pandemic school closures and sport cancellations, lower levels of physical activity and quality of life and increased symptoms of anxiety and depression have been identified in female athletes, team sports players, and areas with a higher percentage of poverty (19). Due to the pandemic, student-athletes who received more social support and reported more connection with teammates reported less dissolution of their athletic identity in a survey before and 1 month after school closure (20).

In Spanish handball players, reduced training intensity, and volume were associated with reduced sleep quality and increased sleep hours during the isolation period (21).

In Brazilian soccer players, over normal off-season, 63 days of quarantine affected several physical performance tests (22).

Although results varied slightly between different sports and geographical regions, the general consensus from studies (12–17, 19, 20) is that athletes are suffering both physically and mentally from the effects of the Covid-19 pandemic and the imposed restrictions and regulations on sporting events. The results from the German prospective longitudinal study suggest that return to sporting activities may be achieved with minimal risk of infection as long as strict hygiene measures are implemented, which suggests that it may be more beneficial to athletes' physical and psychological health if they return to training and sporting events rather than self-isolate (12).

DISCUSSION

Studies investigating the impact of the coronavirus pandemic on public health have found a high level of psychological distress (2). Psychological distress among professional athletes and the pressure they face in competition and success is well-known and can be compounded by adverse events in life (23). Such an adverse event of the coronavirus pandemic made professional athletes especially vulnerable to mental illness with possible implications for general health. Indeed, research reports indicate that athletes are reaching out for mental health support, highlighting pressures of boredom and stress related to the social isolation they are forced to endure. Generally, there was a high prevalence of mental health issues and psychosocial challenges among professional athletes during the coronavirus pandemic. These studies have shown that professional athletes are not immune to this stress and negatively affected. The isolation from their athletic team, reduced activity and training, lack of formal coaching, and lack of social support from fans and media have caused emotional distress in athletes (6).

The evaluated investigations included stressors such as fear of being infected, lack of access to training facilities, lack of ability to continue practicing their skills, canceled matches, lack of social support, and lack of or reduced income. These stressors may lead to outcomes such as disturbed sleep, eating disorders, obsessive-compulsive disorders, family conflicts, and unhealthy coping mechanisms such as smoking and increased alcohol intake. The COVID-19 pandemic impacting the training schedules of athletes has affected their sleeping habits and caused unhealthy habits and coping mechanisms such as increasing their carbohydrate intake and preferring sedentary behavior above active behavior (15). This evidence shows that the effects of lockdown are more severe and multifaceted than just a scheduled absence from training activities.

Another issue that could occur as a result of the constraints imposed is of a financial nature. Competitions, matches, and leagues were canceled due to the outbreak, and this could be the only source of income for certain athletes. While professional athletes in leading leagues do not face the same financial restrictions, cancelations of many sporting events worldwide would impact many teams globally (24). This presents another specific range of concerns, as financial hardship may lead to more psychological distress and, in addition, a decreased income may lead to an inability to afford nutritious food, athletic equipment, or access to training facilities. This may further raise the risk of reduced psychosocial well-being, mental health and well-being, and cardiovascular health.

These outcomes further have consequences on general and cardiovascular health, causing a vicious cycle of events. The potential inability of these athletes to manage their stress and coping mechanisms may lead to long-term depression and other detrimental health effects (25). Although it is difficult to accurately forecast COVID-19's psychological and emotional impact in the current unprecedented situation, we can expect that it can serve as a negative stressor for many athletes.

Mental health cannot be separated from physical health, as mental health symptoms and associated systemic disorders increase the risk of physical injury and delay recovery. Physical activity has beneficial effects for both the prevention and treatment of different diseases and psychiatric diseases such as depressive and anxiety disorders (26). Psychological stress and physical activity have opposite effects on parameters that affect cardiovascular status (27). Even with physical training, cardiovascular disease and risk factors are fairly prevalent in athletes (28). In terms of COVID, having preexisting conditions may lead to worse outcomes, and therefore this is an important aspect to consider when planning the safe return of athletes. Guidelines need to be developed for the diagnosis and management of mental health

symptoms and disorders in elite athletes (29). Cardiorespiratory rehabilitation strategies are essential for a return-to-play with sufficient cardiorespiratory fitness and reduced psychosocial stress in elite athletes after COVID-19 infection (30). Wilson et al. (30) highlight the need to have safe guidelines for athletes to return to normal sporting activities. It also shows how the long-term impact of the disease itself can hinder athletes from returning to normal activities. This would ultimately add to the mental impact of COVID-19 on athletes.

Strengths and Limitations

In the context of the COVID-19 pandemic and professional athletes, the strengths of this analysis include its exploration of peer-reviewed articles. Its drawbacks must, however, also be recognized. In accordance with the scoping analysis procedure, the included articles were not evaluated for accuracy. Study bias may also have been introduced by removing gray literature and non-English language texts. Future studies would benefit from a researching a broader range of bibliographic databases.

CONCLUSION

As exposed in this scoping review, several studies on the impact of the coronavirus pandemic on athletes indicate that this pandemic may act as a triggering life event that would increase occupational stress to afflict mental health and well-being. Afflicted mental health and well-being could also impact their cardiovascular health, which in turn could adversely impact further their mental health. Research on mental and cardiovascular health shall further investigate the identified risk effects brought on from a combination of stressors directly associated with COVID-19 exposure, isolation, lack of physical exercise, reduced income, and fear of unemployment in athletes. Such stressors and their impact on athletes' healthcare should be tackled by psychosocial aid and occupational therapy programs to better deal with the coronavirus pandemic.

AUTHOR CONTRIBUTIONS

OB and LC conceptualized the review and initiated the draft of the manuscript. RH, MA, and DS screened the articles, contributed to the abstraction, and reviewed the manuscript. HA and KD contributed to the abstraction and validation of data and preparation of the manuscript. All authors critically reviewed and revised the final version of the manuscript and contributed significantly to the conceptualization and reporting of the review.

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REFERENCES

1. Meier K, Glatz T, Guijt MC, Piccininni M, van der Meulen M, Atmar K, et al. Public perspectives on protective measures during the COVID-19 pandemic in the Netherlands, Germany and Italy: a survey study. *PLoS ONE*. (2020) 15:e0236917. doi: 10.1371/journal.pone.0236917
2. Dubey S, Biswas P, Ghosh R, Chatterjee S, Dubey MJ, Chatterjee S, et al. Psychosocial impact of COVID-19. *Diabetes Metab Syndr*. (2020) 14:779–88. doi: 10.1016/j.dsx.2020.05.035
3. Giorgi G, Lecca LI, Alessio F, Finstad GL, Bondanini G, Lulli LG, et al. COVID-19-related mental health effects in the workplace: a narrative review. *Int J Environ Res Public Health*. (2020) 17:7857. doi: 10.3390/ijerph17217857
4. Vimercati L, De Maria L, Quarato M, Caputi A, Stefanizzi P, Gesualdo L, et al. COVID-19 hospital outbreaks: protecting healthcare workers to protect frail patients. An Italian observational cohort study. *Int J Infect Dis*. (2021) 102:532–7. doi: 10.1016/j.ijid.2020.10.098
5. Vimercati L, Dell'Erba A, Migliore G, De Maria L, Caputi A, Quarato M, et al. Prevention and protection measures of healthcare workers exposed to SARS-CoV-2 in a university hospital in Bari, Apulia, Southern Italy. *J Hosp Infect*. (2020) 105:454–8. doi: 10.1016/j.jhin.2020.05.024
6. Mehrsafar AH, Gazerani P, Moghadam Zadeh A, Jaenes Sánchez JC. Addressing potential impact of COVID-19 pandemic on physical and mental health of elite athletes. *Brain Behav Immun*. (2020) 87:147–8. doi: 10.1016/j.bbi.2020.05.011
7. Samuel RD, Tenenbaum G, Galily Y. The 2020 coronavirus pandemic as a change-event in sport performers' careers: conceptual and applied practice considerations. *Front Psychol*. (2020) 11:567966. doi: 10.3389/fpsyg.2020.567966
8. Henriksen K, Schinke RJ, Noce F. Working with athletes during a pandemic and social distancing: international Society of Sport Psychology recommendations. *ISSP* (2020).
9. Schinke R, Papaioannou A, Henriksen K, Si G, Zhang L, Haberl P. Sport psychology services to high performance athletes during COVID-19. *Int J Sport Exercise Psychol*. (2020) 18:1–4. doi: 10.1080/1612197X.2020.1754616
10. Byrd M, Carter L, Dieffenbach K, Durand N. *The COVID-19 Pandemic: Tips for Athletes, Coaches, Parents, and the Sport Community*. Bush.
11. Corsini A, Bisciotti GN, Eirale C, Volpi P. Football cannot restart soon during the COVID-19 emergency! A critical perspective from the Italian experience and a call for action. *Br J Sports Med*. (2020) 54:1186–7. doi: 10.1136/bjsports-2020-102306
12. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. (2018) 169:467–73. doi: 10.7326/M18-0850
13. Tricco AC, Lillie E, Zarin W, O'Brien K, Colquhoun H, Kastner M, et al. A scoping review on the conduct and reporting of scoping reviews. *BMC Med Res Methodol*. (2016) 16:15. doi: 10.1186/s12874-016-0116-4
14. Meyer T, Mack D, Donde K, Harzer O, Krutsch W, Rössler A, et al. Successful return to professional men's football. (soccer) competition after the COVID-19 shutdown: a cohort study in the German Bundesliga. *Br J Sports Med*. (2020) 55:62–6. doi: 10.1136/bjsports-2020-103150
15. Pillay L, Janse van Rensburg DCC, Jansen van Rensburg A, Ramagole DA, Holtzhausen L, Dijkstra HP, et al. Nowhere to hide: the significant impact of coronavirus disease 2019 (COVID-19) measures on elite and semi-elite South African athletes. *J Sci Med Sport*. (2020) 23:670–9. doi: 10.1016/j.jsams.2020.05.016
16. Senişik S, Denerel N, Köyagasioglu O, Tunç S. The effect of isolation on athletes' mental health during the COVID-19 pandemic. *Phys Sportsmed*. (2020) 1:1–7. doi: 10.1080/00913847.2020.1807297
17. Costa S, Santi G, di Fronso S, Montesano C, Di Gruttola F, Ciofi EG, et al. Athletes and adversities: athletic identity and emotional regulation in time of COVID-19. *Sport Sci Health*. (2020) 16:609–18. doi: 10.1007/s11332-020-00677-9
18. Håkansson A, Jönsson C, Kenttä G. Psychological distress and problem gambling in elite athletes during COVID-19 restrictions-a web survey in top leagues of three sports during the pandemic. *Int J Environ Res Public Health*. (2020) 17:6693. doi: 10.3390/ijerph17186693

19. McGuine TA, Biese KM, Petrovska L, Hetzel SJ, Reardon C, Kliethermes S, et al. The health of us adolescent athletes during covid-19 related school closures and sport cancellations. *J Athl Train*. (2020). doi: 10.4085/478-20
20. Graupensperger S, Benson AJ, Kilmer JR, Evans MB. Social. (Un)distancing: teammate interactions, athletic identity, and mental health of student-athletes during the COVID-19 pandemic. *J Adolesc Health*. (2020) 67:662–70. doi: 10.1016/j.jadohealth.2020.08.001
21. Mon-López D, de la Rubia Riaza A, Hontoria Galán M, Refoyo Roman I. The impact of covid-19 and the effect of psychological factors on training conditions of handball players. *Int J Environ Res Public Health*. (2020) 17:6471. doi: 10.3390/ijerph17186471
22. Grazioli R, Loturco I, Baroni BM, Oliveira GS, Saciura V, Vanoni E, et al. Coronavirus disease-19 quarantine is more detrimental than traditional off-season on physical conditioning of professional soccer players. *J Strength Cond Res*. (2020) 34:3316–20. doi: 10.1519/JSC.0000000000003890
23. Souter G, Lewis R, Serrant L. Men, mental health and elite sport: a narrative review. *Sports Med Open*. (2018) 4:57. doi: 10.1186/s40798-018-0175-7
24. Toresdahl BG, Asif IM. Coronavirus disease 2019 (COVID-19): considerations for the competitive athlete. *Sports Health*. (2020) 12:221–4. doi: 10.1177/1941738120918876
25. Fatke B, Hölzle P, Frank A, Förstl H. [COVID-19 Crisis: Early Observations on a Pandemic's Psychiatric Problems]. *Dtsch Med Wochenschr*. (2020) 145:675–81. doi: 10.1055/a-1147-2889
26. Peluso MAM, Guerra de Andrade LHS. Physical activity and mental health: the association between exercise and mood. *Clinics*. (2005) 60:61–70. doi: 10.1590/S1807-59322005000100012
27. Labbate LA, Fava M, Oleshansky M, Zoltec J, Littman A, Harig P. Physical fitness and perceived stress. Relationships with coronary artery disease risk factors. *Psychosomatics*. (1995) 36:555–60. doi: 10.1016/S0033-3182(95)71611-5
28. De Matos LDNJ, Caldeira NDAO, Perlingeiro PDS, dos Santos ILG, Negrao CE, Azevedo LF. Cardiovascular risk and clinical factors in athletes: 10 years of evaluation. *Med Sci Sports Exerc*. (2011) 43:943–50. doi: 10.1249/MSS.0b013e318203d5cb
29. Reardon CL, Hainline B, Aron CM, Baron D, Baum AL, Bindra A, et al. Mental health in elite athletes: international olympic committee consensus statement. *Br J Sports Med*. (2019) 53:667–99. doi: 10.1136/bjsports-2019-100715
30. Wilson MG, Hull JH, Rogers J, Pollock N, Dodd M, Haines J, et al. Cardiorespiratory considerations for return-to-play in elite athletes after COVID-19 infection: a practical guide for sport and exercise medicine physicians. *Br J Sports Med*. (2020) 54:1157–61. doi: 10.1136/bjsports-2020-102710

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Impact of Work-Family Conflict on Sleep Complaints: Results From the Longitudinal Study of Adult Health (ELSA-Brasil)

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Background: Balancing work and family demands is often a challenge. Family and job responsibilities may affect many aspects of health, and sleep is an important issue. Work-family conflict (WFC) refers to situations where it is difficult to reconcile family and professional demands. WFC can act in two directions: work-to-family conflicts occur when job demands interfere in family life; family-to-work conflicts arise when family demands interfere with job performance. This study evaluated whether dimensions of WFC—time- and strain-related, work-to-family conflict; family-to-work conflict; and lack of time for self-care and leisure due to work and family demands—were cross-sectionally and longitudinally associated with sleep complaints, by gender.

Methods: The sample comprised 9,704 active workers (5,057 women and 4,647 men) from the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). Standardized questionnaires were used to collect data. WFC was measured at baseline (2008–2010), and sleep complaints were measured at baseline and approximately 4 years after the first visit (2012–2014). To test the association between the four WFC dimensions and sleep complaints, crude and multiple logistic regressions were conducted to estimate odds ratios and 95% confidence intervals. The adjusted model included age, education, marital status, hours worked and work schedule.

Results: Mean age at baseline was 48.2 years. Most participants were educated to University degree level (54.5%), married (68.2%) and worked ≤40 h/week (66.1%). At baseline, 48.3% of women and 41.1% of men reported sleep complaints. Frequent WFC was reported by women and men, respectively, as follows: time-related work-to-family conflict (32.6 and 26.1%), strain-related work-to-family conflict (25.3 and 16.0%), family-to-work conflict (6.6 and 7.6%) and lack of time for self-care (35.2 and 24.7%). For both women and men, time- and strain-related work-to-family conflicts and conflicts for lack of time for self-care were cross-sectionally and longitudinally associated with sleep complaints. The findings also suggest a weaker and non-significant association between family-to-work conflict and sleep complaints.

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Conclusions: The statistically significant associations observed here underline the importance of reducing WFC. In the modern world, both WFC and sleep problems are increasingly recognized as frequent problems that often lead to ill health, thus posing a public health challenge.

Keywords: sleep, work-family conflict, stress, work, epidemiology

INTRODUCTION

Work-family conflict (WFC) is defined as an inter-role conflict that arises when the demands and responsibilities of work and family interfere with each other (1, 2). The concept is bidirectional: work-to-family conflict occurs when work demands interfere with family and personal life; family-to-work conflict occurs when family demands interfere with work. WFC can be characterized as time-related (time devoted to work detracts from participation in the family domain and vice versa) and strain-related (the effort required to perform in one domain can impair performance in the other) (2–4). Another form of conflict results when both work and family demands encroach on time available for personal care and leisure (5).

Balancing work and family demands is often a challenge. Family and job responsibilities may affect many aspects of health, where sleep is an important factor (6, 7). Barnes et al. (8) found that sleep may be impaired among those who spend large amounts of time on both work and family activities, given that time is a finite resource. In addition to the availability of time, pressure from efforts to manage life demands may lead to poorer quality of sleep and reduced total sleep time (7).

Spending a great deal of time on work and on the family leaves less time for sleeping (8). Accordingly, as time becomes scarce, time-related WFC can be postulated to have greater impact on sleep duration. On the other hand, the literature on psychosocial job stress and insomnia complaints (9) suggests that strain-related WFC is a stronger influence.

From this perspective, Helsinki City employees who reported strong WFC were more likely to display sleep complaints (10). Both dimensions of WFC (work-to-family and family-to-work conflict) were similarly associated with sleep complaints (10). Work-to-family, but not family-to-work, conflict was associated with both poor sleep quality and shorter sleep in a sample of information technology workers in the United States (11). In Egypt, significant associations were found between high levels of work-to-family, but not family-to-work conflict, and sleep problems (waking up too early and having difficulty falling asleep again or waking up tired after the usual amount of sleep) (12).

Jacobsen et al. (13), from cross-sectional analyses, found higher levels of WFC significantly associated with sleep deficiency, short sleep duration and perceived sleep insufficiency, but not with sleep maintenance problems (13). However, on a longitudinal approach, they did not find WFC to associate significantly with short sleep and sleep maintenance problems (13). Also, they did not consider the directionality of the conflict (13).

Although women's participation in the workforce has increased in recent decades, the division of family tasks between men and women has remained uneven, especially in countries, such as Brazil, with patriarchal social structures (14). The effects of WFC have been observed among both men and women (4, 15, 16), but some studies have reported women experiencing greater WFC (4, 15). The literature has also shown gender and sex dissimilarities in sleep, which may be explained by both physiological and psychological factors (17, 18). Although some studies have pointed to associations between WFC and sleep complaints in diverse countries, to our knowledge, no studies have been conducted in Brazil, where work polices, household responsibility-sharing and gender roles are quite different from those in most developed countries.

This study explored various dimensions of WFC: time, strain, directionality and the interference by work and family demands in time available for personal care and leisure. The study examined whether dimensions of WFC were cross-sectionally and longitudinally associated with sleep complaints, by gender.

METHODS

Study Design and Participants

The Brazilian Longitudinal Study of Adult Health (ELSA-Brasil) is a prospective cohort study to investigate chronic conditions, such as diabetes and cardiovascular disease. The participants ($n = 15{,}105$) were recruited (Wave 1: 2008–2010) at five public universities and one research institute in six Brazilian cities. Approximately 4 years after the first visit, 14,014 of these civil servants received a follow-up visit (Wave 2: 2012–2014).

This study included 9,704 active workers (5,057 women and 4,647 men) from that cohort with complete data for all variables. Retirees ($n = 3{,}885$) and participants with missing data on any variable ($n = 425$) were excluded.

The ELSA-Brasil study was approved by each institution's research ethics committee and Brazil's National Research Ethics Committee. All participants signed written consent forms before data collection.

Variables of Interest

Standardized questionnaires were used to collect data during in-person visits by standardized, certified teams to the study sites.

Work-Family Conflict

In the first wave, WFC was evaluated using a four-item questionnaire validated for Brazilian Portuguese (5). The first three items were based on the model designed by Frone et al. (3, 19), and the fourth item was developed by Pinto

et al. (5). The four items included: time-related work-to-family conflict ("work demands keep you from spending the amount of time you would like with your family"), strain-related work-to-family conflict ("work demands make it difficult to fulfill domestic responsibilities, such as caring for the household and children"), family-to-work conflict ("family demands interfere with your responsibilities at work, such as getting to work on time, accomplishing daily tasks, work-related travel and attending meetings outside regular working hours"), and the simultaneous effects of both work and family on lack of time for leisure and self-care ("family and work demands keep you from spending the amount of time you would like on your own care and leisure activities"). For each statement, a five-point, frequency-related response scale was used: never to almost never, rarely, sometimes, often and very often. The categories were grouped into three levels: "never/rarely" (reference category), "sometimes" and "often"(4, 5).

Sleep Complaints

Information on sleep complaints was elicited with the following question: "During the past 30 nights, have you had sleep problems (difficulty falling asleep or going back to sleep after waking up in the middle of the night)?" This question derived from the specific section on sleep problems of the Clinical Interview Schedule—Revised (CIS-R) used to assess common mental disorders (20). For the cross-sectional approach, participants who acknowledged having experienced these sleeping problems in Wave 1 were identified as having baseline sleep complaints. For the longitudinal evaluation, those who answered "Yes" in both Waves 1 and 2 were classified in the group with sleep complaints over time; those who answered "No" in both Waves 1 and 2 were classified in the group without sleep complaints over time.

Covariates

Data were also collected on age (continuous), sex, education (upper secondary or university/postgraduate), marital status (married/living together or single/living without partner), children under the age of five in the household (Yes/No), hours worked per week (continuous), and work schedule (exclusively day work, former night work and current night work).

Statistical Analyses

Baseline characteristics were compared, by baseline sleep complaints, using chi-square tests for categorical variables and *t*-tests for continuous variables. To test the association between the four WFC dimensions and sleep complaints (at baseline and over time), crude and multiple logistic regression analyses were conducted to estimate odds ratios (OR) and 95% confidence intervals (CI). The adjusted model included age, education, marital status, hours worked and work schedule. All analyses were performed separately for women and men. Analyses were conducted in R software, version 3.1.2 (R Development Core Team, Vienna, Austria).

RESULTS

Baseline sample mean age was 48.2 (standard deviation = 6.8) years. Most participants were educated to University level (54.5%), were married (68.2%) and worked $\leq$ 40 h/week (66.1%). A total of 41.2% of men and 48.3% of women reported sleep complaints at baseline ($p < 0.001$). Frequent WFC was reported as follows: time-related, work-to-family conflict by 32.6% of women and 26.1% of men ($p < 0.001$); strain-related, work-to-family conflict by 25.3 and 16.0%, respectively ($p < 0.001$); family-to-work conflict by 6.6 and 7.6% ($p = 0.129$); and lack of time for self-care by 35.2 and 24.7% ($p < 0.001$).

Table 1 shows descriptions of sociodemographic and work-related characteristics, by baseline sleep complaints. Sleep complaints by both women and men were associated significantly with time- and strain-related work-to-family conflict, and lack of time for self-care.

Table 2 shows the results of cross-sectional analyses between WFC and sleep complaints. Higher odds ratios were observed for baseline sleep complaints among women who reported experiencing frequent time- and strain-related work-to-family conflict (OR = 1.22; 95%CI: 1.06; 1.42; and OR = 1.35; 95%CI: 1.17; 1.57, respectively), and frequent lack of time for self-care (OR = 1.37; 95%CI: 1.18; 1.58), than among those who reported experiencing conflict "never/rarely." For the men, higher odds ratios were observed for baseline sleep complaints among those who reported frequent time- and strain-related work-to-family conflict (OR = 1.50; 95%CI: 1.27; 1.76; and OR = 1.41; 95%CI: 1.18; 1.47, respectively) and frequent lack of time for self-care (OR = 1.56; 95%CI: 1.17; 1.55), than among men who reported experiencing conflict "never/rarely." In the crude and adjusted analyses, family-to-work conflict was not associated with sleep complaints among either women or men.

Sleep complaints at both Waves 1 and 2 were reported by 31.1% (n = 1,571) of women and 25.1% (n = 1,166) of men. A total of 35.4% (n = 1,789) of women and 44.9% (n = 2,085) of men did not report sleep complaints over time. **Table 3** shows the longitudinal associations between WFC and sleep complaints over time. Among both women and men, sleep complaints over time were associated with work-to-family conflicts and lack of time for self-care, but not with family-to-work conflict. Compared to those who reported experiencing WFC "never/rarely," the highest odds ratio for sleep complaints over time was observed among men who reported frequent lack of time for self-care (OR = 1.85; 95%CI: 1.51; 2.26).

DISCUSSION

This study of the relationship between WFC and sleep complaints revealed that time- and strain-related, work-to-family conflict, as well as lack of time for self-care, were cross-sectionally and longitudinally associated with sleep complaints among both women and men, regardless of confounding variables. The findings also suggest a weaker and non-significant association between family-to-work conflict and sleep complaints.

The findings for the relationship between WFC and sleep, among both women and men, are consistent with results from

TABLE 1 | Baseline characteristics of the study population according to baseline sleep complaints.

	Women (*N* = 5,057) Baseline sleep complaints			Men (*N* = 4,647) Baseline sleep complaints		
	No (*n* = 2,615)	**Yes (*n* = 2,442)**	***p***	**No (*n* = 2,733)**	**Yes (*n* = 1,914)**	***p***
Age (yrs) – Mean [SD]	47.7 [6.8]	48.1[6.4]	0.019	48.5[7.0]	48.4[6.7]	0.787
	n (%)	*n* (%)		*n* (%)	*n* (%)	
Education						
Upper secondary	1060 (40.5)	1063 (43.5)	0.033	1314 (48.1)	976 (51.0)	0.054
University	1555 (59.5)	1379 (56.5)		1419 (51.9)	938 (49.0)	
Marital status						
Married/living together	1,496 (52.2)	1,346 (55.1)	0.142	2,271 (83.1)	1,509 (78.8)	0.001
Non married	1,119 (42.8)	1,096 (44.9)		462 (16.9)	405 (21.2)	
Children						
5 years old	2,322 (88.8)	2,193 (89.8)	0.266	2,353 (86.1)	1,636 (85.5)	0.579
≤5 years old	293 (11.2)	249 (10.2)		380 (13.9)	278 (14.5)	
Work hours						
≤40 h/week	1,860 (71.1)	1,719 (70.4)	0.587	1,686 (61.7)	1,153 (60.2)	0.333
>40 h/week	755 (28.9)	723 (29.6)		1,047 (38.3)	761 (39.8)	
Work schedule						
Day worker	2,197 (84.0)	1,990 (81.5)	0.054	2,207 (80.8)	1,503 (78.5)	0.079
Former night worker	239 (9.1)	265 (10.8)		347 (12.7)	287 (15.0)	
Current Night worker	179 (6.9)	187 (7.7)		179 (6.5)	124 (6.5)	
Time-related work-to-family conflict						
Never/rarely	1,073 (41.0)	876 (35.9)	0.001	1,195 (43.7)	726 (37.9)	<0.001
Sometimes	816 (31.2)	832 (34.1)		646 (23.7)	568 (29.7)	
Often	726 (27.8)	734 (30.0)		892 (32.6)	620 (32.4)	
Strain-related work-to-family conflict						
Never/rarely	1,231 (47.1)	1,002 (41.0)	<0.001	1,548 (56.6)	951 (49.7)	<0.001
Sometimes	604 (23.1)	677 (27.7)		400 (14.6)	345 (18.0)	
Often	780 (29.8)	763 (31.2)		785 (28.7)	618 (32.3)	
Family-to-work conflict						
Never/rarely	1,802 (68.9)	1,611 (66.0)	0.080	1,836 (67.2)	1,239 (64.7)	0.221
Sometimes	168 (6.4)	167 (6.8)		201 (7.3)	153 (8.0)	
Often	645 (24.7)	664 (27.2)		696 (25.5)	522 (27.3)	
Lack of time for self-care						
Never/rarely	910 (34.8)	687 (28.1)	<0.001	1,270 (46.5)	730 (38.1)	<0.001
Sometimes	870 (33.3)	911 (37.3)		608 (22.2)	539 (28.2)	
Often	835 (31.9)	844 (34.6)		855 (31.3)	645 (33.7)	

Brazilian longitudinal study of adult health (ELSA-Brasil, 2008–2010; N = 9,704).

previous studies. WFC has been found to be associated with sleep complaints among both women and men, independent of occupational class, marital status, work arrangements and health behavior (10). Nevertheless, contrary to our results, the strength of the association found was greater for women than men (10). Magee et al. (21) found that the association between WFC and poor sleep quality was more marked among men than women.

Given the higher percentages of women often observed experiencing WFC (15, 22) and considering that sleep complains are usually more prevalent among women than men (23, 24), the association between WFC and sleep complaints among men found in this study should be noted. Men still participate much less in domestic and family activities than women. In recent years, however, society has increasingly demanded that men involve themselves in non-work-related tasks. From that perspective, despite traditional gender-related attitudes, men possibly find it difficult to cope with this "new pressure" in the modern world, that is, the need to maintain their performance at work, while having to devote more time to family. Considering work arrangements, Remery and Schippers (22) argued that job flexibility factors (e.g., working hours) can explain the level of WFC perceived by workers. However, these findings are not yet completely understood, and the question remains open.

As with the findings of this study, so other studies found no statistically significant associations between family-to-work conflict and poor sleep (11, 25). Eshak (12) observed, among Egyptians, that both work-to-family and family-to-work conflicts were associated with short sleep duration. On the other hand, he found no significant association between family-to-work

TABLE 2 | Cross-sectional associations between work-family conflict, lack of time for self-care and sleep complaints at baseline.

	Baseline sleep complaints		
	Crude model OR (95%CI)	Adjusted model 1 OR (95%CI)	Adjusted model 2 OR (95%CI)
Women (n = 5,057)			
Time-related work-to-family conflict			
Sometimes	1.24 (1.08;1.42)	1.27 (1.10;1.45)	1.23 (1.07;1.42)
Often	1.25 (1.10;1.42)	1.29 (1.12;1.48)	1.22 (1.06;1.42)
Strain-related work-to-family conflict			
Sometimes	1.20 (1.06;1.39)	1.24 (1.08;1.41)	1.25 (1.09;1.43)
Often	1.38 (1.20;1.58)	1.43 (1.24;1.65)	1.35 (1.17;1.57)
Family-to-work conflict			
Sometimes	1.15 (0.89;1.39)	1.17 (1.03;1.33)	1.12 (0.98;1.28)
Often	1.11 (1.01;1.31)	1.12 (0.89;1.40)	1.05 (0.84;1.32)
Lack of time for self-care			
Sometimes	1.34 (1.17;1.54)	1.40 (1.21;1.61)	1.37 (1.19;1.59)
Often	1.39 (1.21;1.59)	1.48 (1.28;1.70)	1.37 (1.18;1.58)
Men (n = 4,647)			
Time-related work-to-family conflict			
Sometimes	1.14 (1.00;1.31)	1.17 (1.01;1.35)	1.16 (1.01;1.34)
Often	1.45 (1.25;1.67)	1.51 (1.29;1.77)	1.50 (1.27;1.76)
Strain-related work-to-family conflict			
Sometimes	1.28 (1.12;1.46)	1.31 (1.14;1.50)	1.28 (1.12;1.47)
Often	1.40 (1.19;1.66)	1.45 (1.22;1.72)	1.41 (1.18;1.47)
Family-to-work conflict			
Sometimes	1.11 (0.97;1.27)	1.13 (0.99;1.30)	1.09 (0.95;1.25)
Often	1.13 (0.90;1.41)	1.12 (0.90;1.40)	1.04 (0.83;1.31)
Lack of time for self-care			
Sometimes	1.31 (1.14;1.51)	1.36 (1.19;1.57)	1.35 (1.33;1.84)
Often	1.54 (1.33;1.79)	1.66 (1.42;1.95)	1.56 (1.17;1.55)

Brazilian longitudinal study of adult health (ELSA-Brasil; N = 9,704).
For all models, the reference category is "never/rarely" frequency of work-family conflict at baseline (within each work-family conflict domain). The outcome is baseline sleep complaints: Yes/No. Adjusted model 1: adjusted for age, education, marital status, working hours, and work schedule. Adjusted model 2: adjusted for model 1, plus job strain and depression.

TABLE 3 | Longitudinal associations between work-family conflict, lack of time for self-care and sleep complaints over time.

	Sleep complaints over time		
	Crude model OR (95%CI)	Adjusted model 1 OR (95%CI)	Adjusted model 2 OR (95%CI)
Women (n = 3,360)			
Time-related work-to-family conflict			
Sometimes	1.40 (1.18;1.66)	1.44 (1.21;1.70)	1.38 (1.16;1.65)
Often	1.47 (1.25;1.72)	1.53 (1.29;1.82)	1.46 (1.22;1.75)
Strain-related work-to-family conflict			
Sometimes	1.30 (1.11;1.53)	1.35 (1.15;1.59)	1.37 (1.16;1.62)
Often	1.67 (1.41;1.98)	1.76 (1.47;2.10)	1.65 (1.37;1.98)
Family-to-work conflict			
Sometimes	1.23 (1.05;1.44)	1.25 (1.07;1.47)	1.18 (1.00;1.39)
Often	1.26 (0.96;1.67)	1.27 (0.96;1.68)	1.15 (0.86;1.54)
Lack of time for self-care			
Sometimes	1.51 (1.27;1.79)	1.58 (1.33;1.88)	1.55 (1.30;1.85)
Often	1.60 (1.35;1.89)	1.71 (1.43;2.03)	1.57 (1.31;1.88)
Men (n = 3,251)			
Time-related work-to-family conflict			
Sometimes	1.18 (0.99;1.40)	1.20 (1.01;1.43)	1.20 (1.00;1.43)
Often	1.68 (1.40;2.00)	1.73 (1.44;2.10)	1.70 (1.40;2.07)
Strain-related work-to-family conflict			
Sometimes	1.42 (1.20;1.67)	1.45 (1.23;1.72)	1.40 (1.18;1.67)
Often	1.76 (1.44;2.14)	1.82 (1.48;2.24)	1.76 (1.42;2.18)
Family-to-work conflict			
Sometimes	1.24 (1.06;1.46)	1.26 (1.07;1.49)	1.21 (1.02;1.44)
Often	1.31 (0.99;1.73)	1.31 (0.99;1.73)	1.17 (0.87;1.56)
Lack of time for self-care			
Sometimes	1.50 (1.27;1.78)	1.55 (1.31;1.85)	1.52 (1.28;1.81)
Often	1.87 (1.56;2.25)	2.01 (1.66;2.45)	1.85 (1.51;2.26)

Brazilian Longitudinal Study of Adult Health (ELSA-Brasil; N = 6,611).
For all models, the reference category is "never/rarely" frequency of work-family conflict at baseline (within each work-family conflict domain). The outcome is sleep complaints in waves 1 and 2: Yes/No. Adjusted model 1: adjusted for age, education, marital status, working hours, and work schedule. Adjusted model 2: adjusted for model 1, plus job strain and depression.

conflict and sleep complaints (waking up several times per night, waking up too early and being unable to fall asleep again or waking up tired after a usual amount of sleep) (12). In a sample of information technology industry workers, high levels of work-to-family conflict were associated with poor sleep quality, whereas family-to-work conflict was not (11). In contrast, Lallukka et al. (10) found that both dimensions (work-to-family and family-to-work conflict) were associated with sleep complaints.

Lack of time for self-care has not been explored in depth in the literature and no conclusions can be drawn by comparing with other data. The findings of this study could be explained partly by the link between WFC and unhealthy behavior, such as physical inactivity and unhealthy food habits (26, 27), given that a lifestyle featuring psychosocial stress, unbalanced diet and lacking in physical activity is recognized as a risk factor for sleep problems (28). A recent study of WFC and ideal cardiovascular health scores, using data from ELSA-Brasil, found that workers reporting frequent lack of time for self-care showed lower prevalence of ideal physical activity (29). Also, Svedberg et al. (30), in a study on time pressure, sleep problems and sick leave, argued that the absence of limits between work and leisure can affect sleep and recovery from work (30).

Although these results refer to a pre-pandemic period, recent studies on occupational and behavioral changes relating to the Covid-19 pandemic raised the difficulty of reconciling domestic and family demands, and the related impact on health. The sudden and unexpected changes in workers' routines due to the pandemic have intensified the challenge of defining boundaries between the professional and family spheres. Workers have been

forced to create a work area in their homes, and many employees have found themselves working overtime. Also, for those with children at home, it has become harder to focus work tasks. On the other hand, to stop thinking about work is also a challenge, which can increase stress and impair mental health (31). A study conducted during the pandemic showed an association between stress levels and sleep problems that have emerged during the pandemic (32). In that study sample, greater stress was observed in individuals who needed to align with quarantine-related changes in work, those with family responsibilities, those who needed to wake up early and those with chronic illnesses (32).

This study has certain limitations. Firstly, sleep complaints were recorded only twice, with a 4-year interval and with no information on chronic sleep problems. While WFC was measured at the ELSA-Brasil baseline, the questions relating to sleep complaints in the prior month were asked at both baseline and wave 2. In order to investigate the relation between these factors, further information based on more points of measurement can be evaluated over time in future waves of the ELSA-Brasil. Also, recall bias in self-reported sleep patterns could not be ruled out. However, self-reported sleep measurements have been widely used in large epidemiological studies. Given that the ELSA-Brasil participants comprise a sample of specific civil servants, with higher average income and schooling than the national average, the findings should be generalized with caution, since the perception of work-family conflict and its effects on sleep may be influenced by economic status. Despite these limitations, this study assessed WFC carefully, considering its directionality and all dimensions separately, and thus contributes to the literature on WFC and sleep, given the heterogeneity in the studies as to manners of measuring WFC. Although domestic and family responsibilities are still greater for women, this study's findings raise the hypothesis that frequent WFC may also have strong effects on men's sleep, which deserves to be investigated in depth by future studies. Attention is also drawn to the analysis of lack of time for personal care (simultaneous demands by both work and family depriving the individual of time for self-care), which was not explored in previous studies on sleep, and reinforces how detrimental WFC may be to the quality of sleep.

In conclusion, the associations between WFC and sleep patterns underscore the importance of reducing WFC. This constitutes a public health challenge, since both WFC and sleep problems are increasingly recognized as frequent problems in the modern world. WFC reflects the imbalance between work and family, the two most important spheres of adult life. In addition, sleep complaints may also result from the mounting obligations and responsibilities imposed by domestic and work demands. As both WFC and sleep have been investigated as risk factors for a series of chronic diseases, management of these problems may attenuate the adverse effects of WFC and sleep problems, separately or in combination. These findings may contribute to the development and/or improvement of public policies for actions by labor institutions toward work-family balance. In other words, the results offer information that can also be used to raise awareness among managers, workers and their families in building strategies to promote work-family balance. Also, workplace health policymakers need to take a systemic view that regards the human factor as essential to workplace productivity and recognizes that workers' lives are influenced by both family and work. In sum, this is an important and timely issue.

DATA AVAILABILITY STATEMENT

The ELSA-Brasil study, while open to any researcher, has a policy of requiring that all proposals of investigations pass through the study's publications committee. Requests to access the datasets should be directed to Dr. Rosane H. Griep (rohgriep@gmail.com).

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the research ethics committees of all six centers (Federal University of Minas Gerais—UFMG: 186/06; São Paulo University—USP: 669/06; Federal University of Rio Grande do Sul—UFRGS: 194/061; Federal University of Espírito Santo—UFES: 041/06; Federal University of Bahia—UFBA: 027/06; Oswaldo Cruz Foundation—FIOCRUZ: 343/06). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AS-C wrote the first draft of the manuscript and contributed to data analyses. RG, LR, MF, ST, and MV participated in the study design and provided technical advice during the data analysis. All authors interpreted the results, critically revised the manuscript draft and approved the final version of the manuscript for submission.

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REFERENCES

1. Byron K. A meta-analytic review of work-family conflict and its antecedents. *J Vocat Behav.* (2005) 67:169–198. doi: 10.1016/j.jvb.2004.08.009
2. Greenhaus JH, Beutell NJ. Sources of conflict between work and family roles. *Acad Manag Stable.* (1985) 10:76–88.
3. Frone MR, Russell M, Cooper ML. Relation of work-family conflict to health outcomes: a four-year longitudinal study of employed parents. *J Occup Organ Psychol.* (1997) 70:325–35. doi: 10.1111/j.2044-8325.1997.tb00652.x
4. Griep RH, Toivanen S, van Diepen C, Guimarães JMN, Camelo LV, Juvanhol LL, et al. Work-family conflict and self-rated health: the role of gender and educational level: baseline data from the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). *Int J Behav Med.* (2016) 23:372–82. doi: 10.1007/s12529-015-9523-x
5. Pinto KA, Menezes GM, Griep RH, Lima KT, Almeida MC, Aquino EM. Work-family conflict and time use: psychometric assessment of an instrument in ELSA-Brazil. *Rev Saude Publica.* (2016) 50:39. doi: 10.1590/S1518-8787.2016050005892
6. Edge CE, Cooper AM, Coffey M. Barriers and facilitators to extended working lives in Europe: a gender focus. *Public Health Rev.* (2017) 38:2. doi: 10.1186/s40985-017-0053-8
7. Skinner N, Dorrian J. A work-life perspective on sleep and fatigue – looking beyond shift workers. *Ind Health.* (2015) 53:417–26. doi: 10.2486/indhealth.2015-0009
8. Barnes CM, Wagner DT, Ghumman S. Borrowing from sleep to pay work and family: expanding time-related conflict to the broader non-work domain. *Pers Psychol.* (2012) 65:789–819. doi: 10.1111/peps.12002
9. Yang B, Wang Y, Cui F, Huang T, Sheng P, Shi T, et al. Association between insomnia and job stress: a meta-analysis. *Sleep Breath.* (2018) 22:1221–31. doi: 10.1007/s11325-018-1682-y
10. Lallukka T, Rahkonen O, Lahelma E, Arber S. Sleep complaints in middle-aged women and men: the contribution of working conditions and work-family conflicts. *J Sleep Res.* (2010) 19:466–77. doi: 10.1111/j.1365-2869.2010.00821.x
11. Buxton OM, Lee S, Beverly C, Berkman LF, Moen P, Kelly EL, et al. Work-family conflict and employee sleep: evidence from IT workers in the Work, Family and Health Study. *Sleep.* (2016) 39:1871–82. doi: 10.5665/sleep.6172
12. Eshak ES. Work-to-family conflict rather than family-to-work conflict is more strongly associated with sleep disorders in Upper Egypt. *Ind Health.* (2019) 57:351–8. doi: 10.2486/indhealth.2018-0091
13. Jacobsen HB, Reme SE, Sembajwe G, Hopcia K, Stoddard AM, Kenwood C, et al. Work-family conflict, psychological distress, and sleep deficiency among patient care workers. *Workplace Health Saf.* (2014) 62:282–91. doi: 10.1177/216507991406200703
14. IBGE – Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Amostras por Domicílio – PNAD: Mulheres dedicam mais horas aos afazeres domésticos e cuidado de pessoas, mesmo em situações ocupacionais iguais a dos homens (2018). Available online at: https://agenciadenoticias.ibge.gov.br/agencia-sala-de-imprensa/2013-agencia-de-noticias/releases/24266-mulheres-dedicam-mais-horas-aos-afazeres-domesticos-e-cuidado-de-pessoas-mesmo-em-situacoes-ocupacionais-iguais-a-dos-homens (accessed October 24, 2020).
15. Leineweber C, Baltzer M, Magnusson Hanson LL, Westerlund H. Work-family conflict and health in Swedish working women and men: a 2-year prospective analysis (the SLOSH study). *Eur J Public Health.* (2013) 23:710–6. doi: 10.1093/eurpub/cks064
16. Carvalho VS, Chambel MJ, Neto M, Lopes S. Does work-family conflict mediate the associations of job characteristics with employees' mental health among men and women? *Front Psychol.* (2018) 9:966. doi: 10.3389/fpsyg.2018.00966
17. Mallampalli MP, Carter CL. Exploring sex and gender differences in sleep health: a Society for Women's Health Research Report. *J Womens Health.* (2014) 23:553–62. doi: 10.1089/jwh.2014.4816
18. Suh S, Cho N, Zhang J. Sex differences in insomnia: from epidemiology and etiology to intervention. *Curr Psychiatry Rep.* (2018) 20:69. doi: 10.1007/s11920-018-0940-9
19. Frone MR, Russell M, Cooper ML. Antecedents and outcomes of work-family conflict: testing a model of the work-family interface. *J Appl Psychol.* (1992) 77:65. doi: 10.1037/0021-9010.77.1.65
20. Nunes MAA, Alves MGM, Chor D, Schmidt MI, Duncan BB. Adaptação transcultural do CIS-R (Clinical Interview Schedule – Revised Version) para o Português no Estudo Longitudinal de Saúde do Adulto (ELSA). *Rev HCPA.* (2011) 31:487–9.
21. Magee CA, Robinson LD, McGregor A. The work-family interface and sleep quality. *Behav Sleep Med.* (2018) 16:601–10. doi: 10.1080/15402002.2016.1266487
22. Remery C, Schippers J. Work-family conflict in the european union: the impact of organizational and public facilities. *Int J Environ Res Public Health.* (2019) 16:4419. doi: 10.3390/ijerph16224419
23. Garland SN, Rowe H, Repa LM, Fowler K, Zhou ES, Grandner MA. A decade's difference: 10-year change in insomnia symptom prevalence in Canada depends on sociodemographics and health status. *Sleep Health.* (2018) 4:160–5. doi: 10.1016/j.sleh.2018.01.003
24. Krystal AD, Prather AA, Ashbrook LH. The assessment and management of insomnia: an update. *World Psychiatry.* (2019) 18:337–52. doi: 10.1002/wps.20674
25. Crain TL, Hammer LB, Bodner T, Kossek EE, Moen P, Lilienthal R, et al. Work-family conflict, family-supportive supervisor behaviors (FSSB), and sleep outcomes. *J Occup Health Psychol.* (2014) 19:155-167. doi: 10.1037/a0036010
26. Roos E, Sarlio-Lähteenkorva S, Lallukka T, Lahelma E. Associations of work-family conflicts with food habits and physical activity. *Public Health Nutr.* (2007) 10:222–9. doi: 10.1017/S1368980007248487
27. Shukri M, Jones F, Conner M. Relationship between work-family conflict and unhealthy eating: Does eating style matter? *Appetite.* (2018)123:225–32. doi: 10.1016/j.appet.2017.12.027
28. Hafner M, Stepanek M, Taylor J, Troxel WM, van Stolk C. Why sleep matters-the economic costs of insufficient sleep: a cross-country comparative analysis. *Rand Health Q.* (2017) 6:11.
29. Rocco PTP, Bensenor IM, Griep RH, Barreto SM, Moreno AB, Alencar AP, et al. Work-family conflict and ideal cardiovascular health score in the ELSA-brasil baseline assessment. *J Am Heart Assoc.* (2019) 8:e012701. doi: 10.1161/JAHA.119.012701
30. Svedberg P, Mather L, Bergström G, Lindfors P, Blom V. Time pressure and sleep problems due to thoughts about work as risk factors for future sickness absence. *Int Arch Occup Environ Health.* (2018) 91:1051–9. doi: 10.1007/s00420-018-1349-9
31. Toniolo-Barrios M, Pitt L. Mindfulness and the challenges of working from home in times of crisis. *Bus Horiz.* (2020) 64:189–97. doi: 10.1016/j.bushor.2020.09.004
32. Robillard R, Dion K, Pennestri MH, Solomonova E, Lee E, Saad M, et al. Profiles of sleep changes during the COVID-19 pandemic: demographic, behavioural and psychological factors. *J Sleep Res.* (2021) 30:e13231. doi: 10.1111/jsr.13231

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Antimeningococcal Vaccination Coverage Among Healthcare Workers in an Italian University Hospital

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Introduction: Following an outbreak of meningococcal epidemic in 2015 and 2016 in Tuscany, we registered a higher demand for antimeningococcal vaccination (anti-Men ACWY) by Healthcare Workers of the University Hospital of Pisa [Azienda Ospedaliero Universitaria Pisana (AOUP)]. The purpose of this work is to analyze and discuss data on vaccination coverage resulting from this vaccination campaign.

Materials and Methods: We conducted a monocentric study about anti-Men vaccination in the healthcare workers of the AOUP following the outbreak of meningococcal meningitis that occurred mainly in the population of the Tuscan provinces of Pisa, Pistoia, Prato, and Florence. The variables under examination were age, sex, educational qualification, and job profile. Department healthcare workers were vaccinated with two types of conjugated tetravalent vaccines for the A, C, Y, and W135 strains. Data were analyzed using the SPSS software.

Results: The total population of the workers in AOUP was 7,188 subjects; the population considered in the study was 5,889. Between 2015 and 2017, a total of 2,423 subjects (41.1%) underwent anti-Men vaccination. Women, older HCWs, those with a lower educational qualification, doctors, and the HCWs of the maternal and child department, and imaging department recorded a statistically significant better vaccine compliance.

Discussion: The AOUP, implementing the program of the Tuscany Region of vaccination against *Neisseria meningitidis*, has contributed to reduce the incidence of invasive meningococcal disease. Some critical issues remain in the compliance of some sections of the population, despite the high level of adherence recorded in this case, probably also due to the great media coverage of the event.

Keywords: antimeningococcal vaccine, vaccine coverage, healthcare worker, *Neisseria meningitidis*, *Neisseria meningitidis* vaccine

HIGHLIGHTS

- Great media coverage seems to increase compliance to anti-meningococcal vaccination;
- Healthcare workers dealing with more fragile patients tend to adhere more to vaccination even where there is no obligation;
- Vaccination coverage for *Neisseria meningitidis* in healthcare workers is still sub-optimal.

INTRODUCTION

The invasive meningococcal disease (IMD) from *Neisseria meningitidis* is still a frequently fatal pathology. The bacterium currently counts 13 recognized serogroups, among which A, B, C, W135, and Y are the most frequently isolated in the case of illness (1).

Concerning adult population, anti-Men vaccination is recommended in subjects with an increased risk of contracting an invasive infection due to clinical conditions (e.g., subjects with hemoglobinopathies, functional or anatomic asplenia, and splenectomy candidates, those who suffer from congenital or acquired immunodepression, etc.) (2), or to socio-occupational status (e.g., military recruits, college students, and travelers to countries where meningococcal disease is hyperendemic or epidemic) (3). According to the World Health Organization (WHO), specifically for Healthcare Workers (HCWs), anti-Men vaccination is recommended for those employed in microbiology/bacteriological departments (deliberate biological risk or not). It is recommended also for HCW employed in other laboratories that are exposed to biological risks and deal with the execution of chemical–clinical, histo-, and pathological analysis on potentially infected biological materials (4).

In Italy, the anti-Men ACWY vaccination is not mandatory (not even recommended) for the HCWs, with the only exception of laboratory workers (2), who are at 65–184 times of higher risk to develop IMD than the general population (5). For laboratory staff, some European countries are licensing also anti-Men B vaccines (6).

The anti-Men ACWY is considered useful and appropriate for the HCWs employed in departments at high risk of transmission of airborne diseases.

IMD is an endemic disease accountable for an average mortality rate of 5–10% in developed nations, which, however, rises up to 20% if we consider cases complicated by sepsis (7). The ECDC "Annual epidemiological report for 2015" reported 3,112 cases of *Neisseria meningitidis* in Europe and an overall 0.6/100,000/year notification rate of IMD in EU countries, while in the previous year, there were 2,760 cases (8). Data on anti-Men vaccination coverage in the HCWs are limited in the international literature (9, 10) and, to date, we have not found any study concerning the topic carried out in Italy. It would therefore be important to have more data to establish the best strategies for promoting greater coverage in healthcare professionals. The purpose of this work is to analyze and discuss the data of a single center related to the vaccination coverage resulting from this campaign and to compare it with those present at the time in the literature.

MATERIALS AND METHODS

In the period 2015–2017, the anti-Men vaccination with Menveo (GlaxoSmithKline Vaccines S.r.l., Brentford, UK) or Nimenrix (Pfizer Inc, Sandwitch, UK)-conjugated tetravalent vaccine was offered free of charge to all employees ($n = 7{,}188$) of the Azienda Ospedaliero-Universitaria Pisana (AOUP). The exclusion criteria adopted were age > 75 years and the administrative task because this job profile is not related to an interaction with potential infected patients. After the application of exclusion criteria, the studied subjects were 5,889 (1,294 were excluded for the administrative job profile and five for the age > 75 years). Vaccinations were administered by the staff of the Preventive and Occupational Medicine Department of the AOUP within a 3-year period. The anti-Men vaccine was offered at the time of the medical examination for occupational purposes. At the time of vaccination, personal and working data were collected (if not yet present in our database), and both recorded in the management software of the health risk file (Asped2000NE). Recorded data were sociodemographic variables of HCWs, such as age, sex, educational qualification, job profile, ward, and department. Each subject gave his oral and written consent to vaccination protocol and to enrollment in the research, approved by the local ethical committee.

The statistical analysis was performed using SPSS v 20.0 (Statistical Package for Social Sciences). All categorical data (sex, education, job profile, department, and operative unit) were expressed by their frequencies (number and percentage), whereas age was analyzed as mean, standard deviation, and minimum and maximum values. The Geriatric, Oncology, Hematology, Pediatric Oncohematology, Radiotherapy, Infectious Diseases, and Burn Center operative units were considered as a single group in order to verify the prevalence in those working with patients at higher risk of immunodeficiency vs. the other HCWs, in comparable-sized samples.

The statistical differences between several groups were assessed using the Chi-Square test and *T*-Student test. The statistical significance was accepted for $p < 0.05$.

RESULTS

The studied population, enrolled from January 1, 2015 to December 31, 2017, consisted of 5,889 subjects in health care surveillance for their occupational risk factors, with a mean age of 44.91 years (SD = 11.17; min = 23 and max = 75), of 44.5 $\pm$ 11.5 years in the unvaccinated group, and of 45.5 $\pm$ 10.7 in the vaccine group. Of the population, 68.1% ($n = 4{,}010$) were females and 31.9% were males ($n = 1{,}879$). Considering all departments, 2,423 subjects (41.1%) accepted the anti-Men vaccination. The vaccination was administered to 666 workers in 2015 (24.5%), to 1,310 in 2016 (54.1%), and to 447 workers in 2017 (18.4%). In **Table 1**, the demographic and occupational data were reported about unvaccinated and vaccinated subjects. Concerning the job profile, we have grouped into the "Technicians" category all non-medical health professions such as, for example, biomedical laboratory technicians, radiology technicians, physiotherapists, rehabilitation technicians, logotherapists, etc.

TABLE 1 | Demographic and occupational data.

Tot (n = 5,889)	Unvaccinated (n = 3,466)	Vaccinated (n = 2,423)	P-value
Age (years)			
Mean, SD	44.5 ± 11.5	45.5 ± 10.7	<0.0001
Sex (n)			
Male (1,879)	1,166 (62.1%)	713 (37.9%)	<0.0001
Female (4,010)	2,300 (57.4%)	1,710 (42.6%)	
Education (n)			
Secondary school (379)	119 (31.4%)	260 (68.6%)	<0.0001
High school (1,582)	981 (62,0%)	601 (38.0%)	
University (3,928)	2,366 (60.2%)	1,562 (39.8%)	
Job profile (n)			
Technicians (898)	593 (66.0%)	305 (34%)	<0.0001
Nurses (2,715)	1,586 (58.4%)	1,129 (41.6%)	
Doctors (2,276)	1,287 (56.5%)	989 (43.5%)	

In **Table 1**, p-value concerns the comparison between sex, education, and different job profiles in the vaccine group.

All the operative units of AOUP were included in the different departments, based on their operative field, and a graphic representation of unvaccinated and vaccinated subjects is reported in **Figure 1**.

The average prevalence of anti-Men vaccination within the entire population of AOUP HCWs was 41.1%. The anti-Men vaccination rates among workers from both the Gynecology/Pediatric and the Imaging Department were significantly higher ($p < 0.0001$ and $p = 0.003$, respectively) than the average rate of all the other HCWs in AOUP (40.4, 40.7%). We also found that some operative units (i.e., Geriatric, Oncology, Hematology, Pediatric Oncohematology, Radiotherapy, Infectious Diseases, and Burn Center operative units) showed singularly as well as cumulatively (44.3 vs. 40.8%, $p = 0.081$) a higher, though not statically significant, rate of anti-Men vaccination when compared with the rest of the AOUP HCWs.

DISCUSSION

The AOUP is one of the largest hospitals in Italy, with high specialization in several clinical fields. In 2017, a total of 58,247 hospitalizations were performed, of which 46,964 were ordinary hospitalizations and 11,283 day hospital admissions, 32,142 for surgical and 26,105 medical treatment (11).

Since the great number of patients is afferent to our hospital, it is important that HCWs are covered from most dangerous infective diseases, like measles, rubella, chickenpox, and meningitis (12).

In Italy, the incidence of IMD in the 3-year period between January 2015 and December 2017 was of 0.31 cases/100,000 inhabitants in 2015 and 0.38 cases/100,000 inhabitants in 2016, lower than the European average of 0.6 cases/100,000 inhabitants (in 2015, the most recent data available)[1]. From 2015, in Tuscany, an anomalous increase in IMD cases from meningococcus was observed, compared with the previous years and the average national data. This situation lasted until 2016: the cases recorded of meningococcal disease in this 2-year period were as many as 61 with an incidence of 0.81/100,000 inhabitants (compared with the 22 total cases notified in the years 2007–2014 with an incidence average of 0.2/100,000 inhabitants). It provoked the death of 13 people, with a lethality of 21.3%. In 2017, thanks also to the undertaken extraordinary vaccination campaign, there was a significant overall reduction: only nine cases occurred, without any death, with an incidence rate falling down to previous statistics (0.24/100,000 inhabitants). The most frequently isolated serogroup was C, followed by the serogroup B, and finally the serogroup Y[1].

Following the outbreak of IMD in Tuscany in 2015, there has been great media coverage of every case that could resemble meningitis, and this highly contributed to a collective psychosis around that. So there has been great debate about the need to propose the anti-Men vaccination at least to the categories with utmost risk of contracting the infection.

The Tuscany Region offered free vaccination from 2015 to December 31, 2018 to people of age between 20 and 45 years living in Tuscany, who got in touch with a patient that further developed IMD or to those who attended at least 10 days earlier the same places or communities where a case of IMD happened[2].

In Italian legislation, there is no vaccination requirement regarding *N. meningitides* (2). Considering, however, that HCWs have an additional risk of contracting this infection compared with the general population, as part of the catch-up campaign, the AOUP, the Preventive and Occupational Medicine Department proposed free vaccination against *N. meningitidis* A, C, W125, and Y to all HCWs undergoing health care surveillance (n = 5,889), excluding administrative workers.

In this study, workers with a major attitude to be vaccinated vs. *N. meningitidis* were females (42.6%, $p < 0.0001$), were older (45.5 ± 10.7 vs. 44.5 ± 11.5, $p < 0.0001$), attended secondary schools (68.6%, $p < 0.0001$), and considering job titles, physicians (43.5%, $p < 0.0001$). These data are in agreement with what were reported by the few previous studies (5, 6). The greater aptitude for vaccination of workers with a lower level of education may be explained by the greater susceptibility to the massive media campaign undertaken by the media during the outbreak period. Another factor to be considered is that, this portion of the population represents the largest pool of previously unvaccinated individuals and, therefore, those who, more than others, adhere to free vaccination campaigns.

If we consider the temporal distribution of the administration of the anti-Men vaccine, we can see how the peak of requests occurred in 2016 (54.1%). This can be easily explained by the peak in the number of cases of IMD by *N. meningitidis* recorded in that year, and by the fact that in the following period, the media

[1]Italian National Health Institute. Surveillance data on invasive bacterial diseases updated on 19 March 2018.

[2]Delibera Regione Toscana n.85 del 16-02-2016.

Departments	*Vaccinated n (%)*
Anesthesia and Resuscitation	207 (41.6%)
Oncology and Medical Area (Allergology, Dermatology, Hematology, Internal Medicine, Sport Medicine, Oncology, Radiotherapy, Reumatology, Breast Clinic)	254 (39.5%)
Cardio-Thoracic and Vascular Medicine (Cardiology, Pneumology, Cardiac Surgery, Thoracic Surgery, Vascular Surgery)	182 (37.7%)
General Surgery (General Surgery, Esophageal Surgery, Bariatric Surgery, Proctological Surgery, Endocrine Surgery, Gastroenterology)	171 (32.4%)
Imaging Department (Radiology, Nuclear Medicine)	176 (48.2%)
Emergency Department (Emergency Surgery, Emergency Medicine, Orthopedics, Maxillofacial Surgery, Geriatrics, Burn Center, Radiology, Anesthesia)	386 (43.2%)
Gynecology and Pediatric (Gynecology & Obstetrics, Pediatrics, Pediatric Oncohematology, Neonatology, Pediatric Intensive Care)	255 (48.8%)
Laboratory Medicine (Anatomic Pathology, Clinical Pathology, Transfusion Center, Clinical Pharmacology, Laboratory, Cytogenetics, Microbiology and virology, Toxicology)	246 (42.5%)
Specialistic Surgery (Hand Surgery, Oral Surgery, Oftalmic Surgery, Plastic Surgery, Neurosurgery, Otolaryngology, Urology)	183 (42.1%)
Specialistic Medicine (Endocrinology, Diabetology, Infectious Diseases, Hepatology, Nefrology, Neurology, Psychiatry, Clinical Psycology)	363 (38.5%)

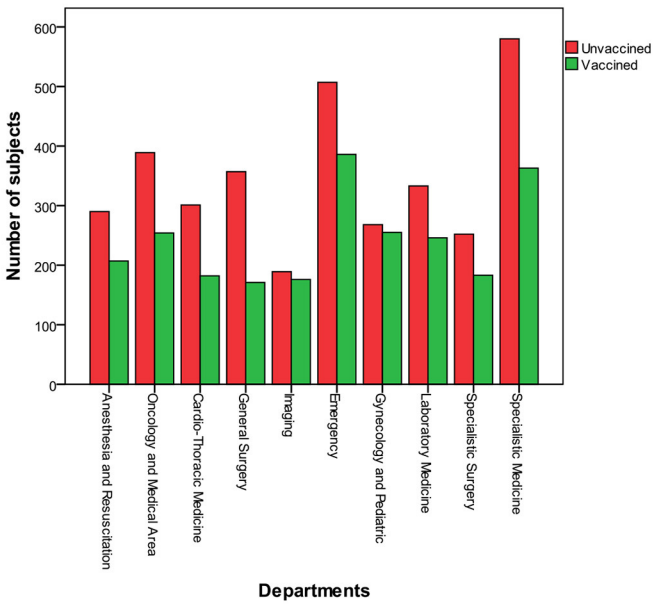

FIGURE 1 | Distribution of vaccine to unvaccinated subjects in different departments, in number and percentage.

attention toward the outbreak has been reduced also due to the decrease in the incidence of pathology.

From the analysis of the vaccination coverage within the various departments, it is not surprising that the greatest prevalence is found in the maternal and child department (48.8 vs. 40.4%, $p < 0.0001$). Here, in fact, HCWs are more sensitive to the problem of being able to transmit an infectious disease to a population particularly at risk of major complications such as pediatric patients.

Another department that showed an increased prevalence of vaccination against *N. meningitidis* was the Imaging Department (48.2 vs. 40.7%, $p = 0.003$). In this case, the largest proportion of employees who may have raised the average may report to the Imaging Department of the Emergency Department, typically more in contact with patients at risk of transmitting infectious diseases.

Two other departments that showed a high adherence to the vaccination campaign offered by the AOUP were the Emergency

department and the "fragile patients" department, in which we artificially collected the Geriatric, Oncology, Hematology, Pediatric Oncohematology, Radiotherapy, Infectious Diseases, and Burn Center operative units in function of the greater presence of patients particularly at risk of acquiring infections or of developing major complications in case of infection. In these departments, however, a statistically significant difference comparing with the remaining AOUP working population was not highlighted, but only an increasing trend. We can explain these results considering that in these departments, workers were generally already vaccinated against the most dangerous pathogens, including *N. meningitidis*.

A limitation of our study is that the vaccine adherence data in some departments may have been underestimated. This may have happened because we did not know the HCW vaccination coverage data before the campaign was implemented by our facility. Another limitation of our study is that our results were derived from a temporally and geographically circumscribed observation. Therefore, the replication of our research through a multicenter design, over a longer time frame, and a larger population of healthcare professionals is needed.

In the considered population, we found a statistically significant difference in the acceptance of the anti-Men vaccine on the basis of the work profile, with a greater compliance by the medical staff with respect to the nursing and technical ones ($p < 0.0001$). These data are in partial disagreement with what were reported in literature, in particular, from the study of Madani et al. (10), which did not find any statistically significant difference in the vaccination compliance between doctors and nurses. Other studies did not investigate the compliance in vaccination based on the job profile.

On the contrary, according to what was reported by Madani et al. (10), also in our population, we found a statistically significant difference in the acceptance of vaccination based on the level of education. As in the aforementioned study, there was greater compliance by the subjects with a lower level of education than those with higher educational qualifications. Subjects with a lower level of education historically represent a population that is more reluctant to vaccination, especially in Italy, where the disinformation linked to possible adverse events to vaccines is always greater. Therefore, the data detected in our study can be explained, at least in part, by the fact that this population represents the largest reservoir of unvaccinated subjects and, therefore, the largest slice of the population to which vaccination will be destined. Moreover, these subjects could be more sensitive to the media campaign undertaken by the local and national media to cover the Tuscan meningitis outbreak.

These data show how the intervention of the AOUP in proposing free anti-Men vaccination to the HCWs, in association with the program of the Tuscan Region, managed to reduce the cases of meningitis up to realign the data of the incidence with that of the other Italian regions.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

VG: conceptualization, methodology, supervision, validation, and writing–review and editing. MN: conceptualization, investigation, and writing–original draft. AB: data curation, formal analysis, and software. AM, FC, and GG: project administration and validation. PF and RF: project administration, supervision, validation, and writing–review and editing. AC: project administration, resources, supervision, software, validation, and writing–review and editing. All authors contributed to the article and approved the submitted version.

REFERENCES

1. Bona G, Guidi C. Evoluzione della vaccinazione antimeningococco. *CMI*. (2012) 6:59–66. doi: 10.7175/cmi.v6i2.627
2. Italian Ministry of Health. *National Vaccination Prevention Plan 2017-2019*. (2019). Rome: Italian Ministry of Health.
3. Centers for Disease Control and Prevention (CDC). Updated recommendations for use of meningococcal conjugate vaccines – Advisory Committee on Immunization Practices (ACIP), 2010. *MMWR*. (2011) 60:72–6.
4. Meningococcal vaccines, WHO position paper. *Wkly Epidemiol Rec*. (2011) 86:521–40. Available online at: https://www.who.int/wer/2011/wer8647/en/
5. Sejvar JJ, Johnson D, Popovic T, Miller JM, Downes F, Somsel P, et al. Assessing the risk of laboratory-acquired meningococcal disease. *J Clin Microbiol*. (2005) 43:4811–4. doi: 10.1128/JCM.43.9.4811-4814.2005
6. Hong E, Terrade A, Taha MK. Immunogenicity and safety among laboratory workers vaccinated with Bexero vaccine. *Hum Vaccin Immunother*. (2017) 13:645–48. doi: 10.1080/21645515.2016.1241358
7. Bröker M, Cooper B, DeTora LM, Stoddard JJ. Critical appraisal of a quadrivalent CRM_{197} conjugate vaccine against meningococcal serogroups A, C, W-135 and Y (Menveo) in the context of treatment and prevention of invasive disease. *Infect Drug Resist*. (2011) 4:137–47. doi: 10.2147/IDR.S12716
8. European Centre for Disease Prevention and Control. *Surveillance of Invasive Bacterial Diaseases in Europe, 2012*. Stockholm: ECDC (2015).
9. Marshall E, Salmon D, Bousfiha N, Togola Y, Ouedraogo F, Santantonio M, et al. Vaccination coverage among social and healthcare workers in ten countries of Samu-social international sites. *Vaccine*. (2017) 35:5291–6. doi: 10.1016/j.vaccine.2017.05.014
10. Madani TA, Ghabrah TM. Meningococcal, influenza virus, and hepatitis B virus vaccination coverage level among health care workers in Hajj. *BMC Infect Dis*. (2007) 7:80. doi: 10.1186/1471-2334-7-80
11. AOUP. *Hospitalization Activity Report*. (2017). Available online at: http://sitovecchio.ao-pisa.toscana.it/index.php?option=com_attachments&task=download&id=26343 (accessed January 7, 2021).

12. Haviari S, Bénet T, Saadatian-Elahi M, André P, Loulergue P, Vanhems P. Vaccination of healthcare workers: a review. *Hum Vaccin Immunother*. 11:2522–37. doi: 10.1080/21645515.2015.1082014

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ORIGINAL RESEARCH
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Importance of Work-Related Psychosocial Factors in Exertion Perception Using the Borg Scale Among Workers Subjected to Heavy Physical Work

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Objective: This study aimed to analyse the role of several environmental and time variables, as well as individual and psychosocial factors, on the perception of exertion, expressed by using the Borg scale, on logistics workers performing heavy manual tasks.

Materials and Methods: We enrolled 56 subjects working in logistics sector that were interviewed on the perceived exertion required to execute a task of manual lifting of heavy loads, by using the Borg scale. The interviews were carried out during different shifts, at different times during the shifts and during several different months of the year. We also assessed the workers' anthropometric characteristics, length of service, any musculoskeletal diseases, and physical activity outside work. Workers were also interviewed using the structured OREGE questionnaire, in order to evaluate the main symptoms of stress and work-related psychosocial risk factors.

Results: Overall, the subjective perception of the strength exerted by the workers exposed to a high risk of manual handling of loads was moderate. The rating attributed using the Borg scale showed no correlation with any of the investigated variables. 100% of the workers denied to suffer from symptoms of stress, whereas in terms of psychosocial factors, the workload was globally perceived as positive.

Conclusion: The study results support the hypothesis that optimal work conditions—from a psychosocial point of view—reduce the subjective perception of exertion by workers even if exposed to a high risk of biomechanical overload.

Keywords: musculoskeletal disorders, biomechanical overload, risk assessment, Borg scale, psychosocial factors

INTRODUCTION

The main methods that are used in ergonomics to assess the risk of biomechanical overload of the musculoskeletal system rely, in general, on subjective effort perception; the Borg scale is indeed one of the most widespread approach used to estimate workers' strain when they are performing their tasks (1). However, it has been well-documented that further biomechanical overload risk factors—such as dimensions, method and frequency of handling, size of the loads, and posture can affect this perception (2–5).

So far, there are no scientific studies, to the best of our knowledge, investigating the effects of additional variables on the workers' perception of exertion, including the time of work-shift, the period of the year, and the microclimatic conditions at the time of the interview. Furthermore, there are even fewer studies examining the influence of psychosocial risk factors on such subjective perception (6–8). In previous articles, we often addressed the critical issue involved with using scales of subjective evaluation for "exerted force," as reported by workers or compiled by experts (1, 9, 10). Indeed, we have been widely highlighting the difficulty in assigning risk scores corresponding to the actual level of exertion, when workers are only given a numerical scale with no explanation of what the scores mean. In our experience, the greater the level and the detail of explanation provided for each rating in the scales used for the interview, the fewer subjective overestimations or underestimations are made by workers regarding the risk and the more the risk scores correspond to those assigned by the experts (11, 12).

Within this scenario, we hypothesize that both the subjective context and working environment, as well as the time of the work-shift, may present direct effects on the exertion rating. Therefore, the main aim of this study was to analyse the influence of several environmental and time variables, as well as individual and psychosocial factors, on the perception of exertion, expressed by using the Borg scale, while performing heavy manual tasks, which involve the manual handling of heavy loads during repeated actions.

SUBJECTS AND METHODS

This study was performed within the Italian branch of an international enterprise that operates in the logistics sector, in the context of the mandatory periodical health surveillance according to the Italian Legislative Decree 81/2008 and further modifications. All the workers involved in manual load handling expressed their consent to participate to the study, that was performed following the WMA Declaration of Helsinki.

The study sample was represented by 56 male subjects, with an average age of 34 years old (range 20-61 years old). All the main workers' characteristics are summarized in **Table 1**.

To define the correct approach for the risk assessment, we preliminary performed an ethnographic on-field analysis, reporting details about the type of manual tasks performed by the workers, the environmental conditions and the planned working shifts.

Accordingly, a risk assessment was carried out into the manual handling of loads, both lifting and pushing-pulling, in accordance with internationally recognized approaches, such as the NIOSH and the psychophysical Snook and Ciriello methods (4, 13). Furthermore, the workers were interviewed on the perceived exertion required to execute a task, by using the Borg scale, which involves assigning a rating ranging between 0 and 10 (1, 14). As previously underlined, while providing the questionnaire we included also the explanations of the numerical ratings, since we reported that interview scales assign much more realistic risk scores if the meaning of said scores are properly explained (10, 11). The interviews were carried out during different shifts, at different times during the shifts (start, middle, and end of shift) and during different months of the year.

TABLE 1 | Characteristics of enrolled workers (no. 56).

Variables	Average ± SD.	Min. - Max.
Age, years	34 ± 10	20-61
Length of service with the company, years	10 ± 7	1-22
Length of service in the role, years	9 ± 6	1-22
BMI, kg/m^2	24.5 ± 3.0	19-31
Distance from work, km	9.5 ± 7.7	1-32
Borg scale rating	3.7 ± 2.0	0.0-10.0

BMI, body mass index.

We also assessed the workers' anthropometric characteristics [Body Mass Index (BMI)], length of service, any documented musculoskeletal diseases, and lifestyles, with reference to regular physical activity outside work.

Workers also received parts 3 and 4 of the OREGE questionnaire (15). Part 3 (18 questions) investigates the main symptoms of stress, including anxiety (nervousness, tremors, dizziness, vertigo); gastrointestinal disorders; the third stage of stress [sensation of intense fatigue or exhaustion, as described by Selye (16), which reduces the body's ability to adapt to stressful stimuli. Part 4 (26 questions) regards psychosocial factors, including overall and current workload; work pressure; attention and control over work; involvement; immediate social support from superior and colleagues; career prospects (two questions)]. The answers to the questionnaires were evaluated by applying the methodology described by the French INRS (Institut National de la Recherche Scientifique, INRS, 2000) (17).

The statistical analysis was performed using the statistics package SPSS 21.0 (IBM Statistics). Descriptive data analysis, analysis of differences between two (Mann-Whitney analysis) or more groups (Kruskall-Wallis test) and Spearman's correlation analysis were applied. Finally, a factorial variance analysis with normalized Varimax rotation was applied to the psychosocial risk factors.

RESULTS

Table 1 shows that enrolled workers presented an average length of service with the company of 10 ± 6 years and an average BMI of 24.5 ± 3.0 kg/m^2; they used to live close to the company (distance between home and work < 10 km) and usually travel to work by car. Seven workers reported episodic lower back

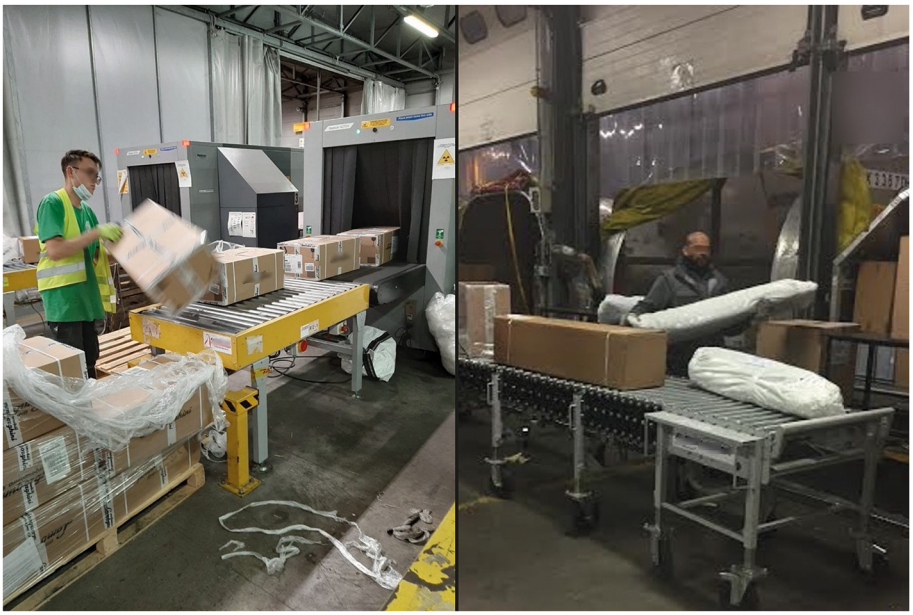

FIGURE 1 | Manual handling of parcels of different weights and dimensions.

FIGURE 2 | The unit load device (ULD) is pushed by the operators inside the upper deck of a Cargo Aircraft.

pain with a diagnosis of disc disease and one worker suffers from chronic epicondylitis. Thirty-two workers (57%) regularly perform exercise at least twice a week.

From the ethnographic analysis, we reported that warehouse staff were specifically employed to empty and fill incoming and outgoing containers, manually handling packages of varying shapes and sizes (**Figure 1**). Ramp operators were addressed to push the containers up the ramp and load them into the aircraft (**Figure 2**). Given the variable nature of the loads to be handled, lifting equipment could not generally be used as aid in these activities; few pneumatic lifting devices were provided only in certain workstations within the warehouse, but these systems could not be widely used due to the package different sizes. The ramp operators always work outdoors, regardless of the weather conditions, while the warehouse staff works in a closed environment with air conditioning, handling loads with greater frequency. The Supervisors (SPVs) coordinate the teams and may provide their support to perform manual tasks, where necessary.

Concerning the working daily planning, work was organized across 27 different types of shifts with different durations (median 7 h; min. 3 h, max. 10 h), with times ranging between 6 p.m. and 12 a.m. and, in most cases, including a number of nocturnal hours (from 0 to 5 h, median 2 h 30 min) defined in accordance with the Italian legislation (Legislative Decree no. 66/2003; work between midnight and 7 a.m.).

The risk assessment into the manual handling of loads as part of lifting and handling operations, as well as pushing-pulling containers, highlighted very high-risk scores (much higher than 3), due to both the weight of the objects being handled and way they are handled, as well as the size of the loads. However, the subjective perception of the strain was not as high, with an average rating of 3.7 ± 2.0 on the Borg scale.

Table 2 shows the breakdown of the ratings obtained in the subgroups of workers classified by their role, areas of prevalent muscular effort, whether or not they suffer from diseases affecting the spine or upper limbs, the time of the interview, the period of the year (hot months vs. cold months) and whether or not they perform regular exercise. There were no cases of statistically significant differences in the perception of exerted force among the different subgroups.

In addition, the rating attributed using the Borg scale showed only a slight significant positive relationship with duration of the

specific job (R^2 0.07, beta 0.27, $p < 0.05$), but not with working hours/day, worked hours, work-shift, month (season) and time of the interview, BMI and home distance from the workplace (data not shown).

As regards the OREGE questionnaire, 100% of the workers denied suffering from symptoms of stress (Part 3 of the Questionnaire, data not shown). In terms of psychosocial risk factors, the workload was perceived as being demanding both generally speaking (100%) and at the time of the interview (80%); work was judged not pressing (100% of workers); work required attention (100% of workers), control (100% of workers), and workers' involvement (98%); at work there was a good social support from the boss and colleagues (100%), with no concern about future job prospects (100%) (**Supplementary Table 1**). These results were indeed expected, as they are typical of the investigated sector. In logistics, infact the workers have little organizational influence that depends on sophisticated softwares and management systems, but they have high commitment to work and influence on overall work quality that requires a great professionalism and experience.

The questionnaires on psychosocial factors were therefore evaluated statistically by factorial analysis, excluding the questions about "social support from the boss" and "social support from colleagues," that gained the same answers across workers. The analysis showed that 37% of the overall variance of psychosocial risk factors was explained by two components, including work pressure and current workload (first component) and professional future and involvement (second component) (**Table 3**).

TABLE 2 | Distribution of Borg's ratings [median (interquartile range)] in workers classified by occupational, environmental, time, and individual variables.

Variables (*N*)	Borg's score, median (IQR)	
Role	Warehouse ($N = 38$)	3.00 (2.38-6.00)
	Ramp ($N = 18$)	3.00 (2.75-4.00)
Body part under exertion	Upper limbs ($N = 9$)	3.00 (2.00-3.75)
	Upper limbs > Spine ($N = 2$)	5 (3.00)
	Spine ($N = 33$)	3 (2.25-4.50)
	Spine > Upper limbs ($N = 12$)	4 (3.00-5.50)
Time of the shift	First half of shift ($N = 22$)	3 (3.00-6.00)
	Second half of shift ($N = 21$)	3.50 (2.00-4.00)
	Off shift ($N = 13$)	3.00 (2.00-4.00)
Months	October-March ($N = 34$)	3 (2.38-4.00)
	April-September ($N = 22$)	3 (2.75-4.25)
Spine or upper limb diseases	Yes ($N = 8$)	5.00 (3.00-6.00)
	No ($N = 48$)	3.00 (2.13-4.00)
Regular exercise	Yes ($N = 32$)	3.00 (2.25-5.50)
	No ($N = 24$)	3.00 (2.63-4.00)

There are no statistically significant differences among the different subgroups.

DISCUSSION AND CONCLUSIONS

The main aim of the study was to verify the interference of individual and environmental factors, including BMI, health status, age, length of service, microclimatic conditions, work-shift, time of the shift, performing regular exercise outside work on the subjective perception of physical exertion while performing a work with a very high risk of biomechanical overload by manually handling loads. Unlike what we expected according to literature data, the study results underline that the exertion perception is not significantly influenced by the job or by any other environmental, time and individual variables taken into consideration (2, 6, 8, 18).

In our opinion, such results should be interpreted largely considering the outcomes obtained in the OREGE questionnaires, in particular the part investigating psychosocial factors. The investigated worker sample can be mainly described as a working population with no stress symptoms, a good company environment, a good salary, career prospects, managers who pay attention to the workers' needs, good horizontal and vertical relationships, confidence in the future of the company and job security. The worker study group was constituted by: university students who preferentially work in the evening/night and can study in the morning/afternoon; moms who usually cover the shift 22:00-01:00, when the children sleep; fathers who work 6 h and are paid as for 8 h. The ramp agents have a very high salary, including several allowances. The company-worker relationship was very good.

TABLE 3 | Results of the factorial analysis of psychosocial risk factors.

	1	2	3	4
Work pressure	0.834			
Current workload	0.795			
Professional future		0.884		
Involvement		−0.532	0.505	
Workload in general			0.846	
Control over work				0.732
Attention				−0.579
Variance (70%)	19%	18%	17%	16%

37% of the variance is explained by the first four psychosocial factors, in bold.

Further, the evidence that even the time of the shift when the workers were interviewed had no influence on the obtained results could be interpreted specifically considering the psychosocial factors; more in detail, these subjects gave positive feedback about night shifts, receiving full-time pay for reduced hours (6 h), which enable them to perform further activities during the day (e.g., study, family, second job, etc.). These findings are in agreement with studies highlighting how psychosocial factors can play a decisive role in the perception of disorders and in the assessment of the risk of biomechanical overload of the upper limbs (7, 19–24). On the other hand, psychosocial discomfort can lead to incorrect working practices, which can amplify the effects of risk factors specific to the role, despite not necessarily being significant in themselves (12, 25).

We recognize that our study is affected by main limitations, including (i) its cross-sectional study design making it impossible to determine direction of causation and raising the possibility that the study sample was unrepresentative because of healthy worker selection; (ii) the small sample size and the possibility that relationships were missed because of inadequate statistical power. The results would need confirmation by a different study design, and a larger sample size. According to the experience of the principal investigator, who was the occupational health physician of the company by long time, the obtained results were not affected by the healthy worker effect, as the worker group was stable over years. The obtained results are in agreement with our previous studies, highlighting the role of work-related psychosocial risk factors on the workers' perception of exertion and the extent to which the subjective methods of estimating exertion are affected by these factors in terms of overestimating or underestimating the real risk (10–12). Therefore, a reliable evaluation of exertion should be based on the quantification of objective parameters using several tools able to acquire environmental and physiological information—such as electromyography, dynamometers, load cells, and inertial sensors—combined with ergonomic methodologies of risk assessment (3, 5, 15, 26–30).

In conclusion, in the specific investigated setting, the study allows us to hypothesize that optimal work conditions—from a psychosocial point of view—could be the reason for subjective underestimation of exertion by workers exposed to a high level of risk of biomechanical overload.

We also want to emphasize the importance of proper health surveillance even in optimal situations from the point of view of psychosocial factors. Workers exposed to heavy duty jobs, but "apparently" ignoring its hardness may have clinical problems and even occupational illness, if neglected; but the workers of our study, undergo periodic and accurate health checks by the occupational physician who has assessed the worker's health status for many years with targeted questionnaires on symptoms, objective examination and second level examinations, when required.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

ES and GD conceptualized and designed the study and made the decision to submit. ES designed the data collection instrument and administered the questionnaires to the workers. CT did the statistical analyses. ES, NL, FR, AM, and PA analyzed the data and commented on the manuscript. All authors critically revised the paper, approved the final study, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.678827/full#supplementary-material

REFERENCES

1. Borg G. *Borg's Perceived Exertion and Pain Scales*. Champaign, IL: Human Kinetics (1998).
2. Losa Iglesias ME, Becerro De Bengoa Vallejo R, Salvadores Fuentes P. Self-reported musculoskeletal disorders in podiatrists at work. *Med Lav.* (2011) 102:502–10.
3. Shafti A, Lazpita BU, Elhage O, Wurdemann HA, Althoefer K. Analysis of comfort and ergonomics for clinical work environments. *Ann Int Conf IEEE Eng Med Biol Soc.* (2016) 1894–7. doi: 10.1109/EMBC.2016.7591091
4. Snook SH, Ciriello VM. The design of manual handling tasks: revised tables of maximum acceptable weights and forces. *Ergonomics.* (1991) 34:1197–213. doi: 10.1080/00140139108964855
5. Torri D, Sala E, Orizio C, Apostoli P. Stima della presa in pinch: approfondimento degli aspetti metodologici ed applicativi mediante l'impiego di un nuovo apparato portatile, P force Met [Pinch assessing in bio mechanical analysis: methodological and applicative aspects dealt by using the new P force Met portable instrument]. *G Ital Med Lav Ergon.* (2011) 33:63–73.
6. Colim A, Arezes P, Flores P, Braga AC. Effects of workers' body mass index and task conditions on exertion psychophysics during vertical handling tasks. *Work.* (2019) 63:231–41. doi: 10.3233/WOR-192923
7. Otto A, Emery K, Côté JN. Sex differences in perceptual responses to experimental pain before and after an experimental fatiguing arm task. *Biol Sex Differ.* (2019) 10:39. doi: 10.1186/s13293-019-0253-7
8. Shariat A, Cleland JA, Danaee M, Alizadeh R, Sangelaji B, Kargarfard M, et al. Borg CR-10 scale as a new approach to monitoring office exercise training. *Work.* (2018) 60:549–54. doi: 10.3233/WOR-182762
9. Latko WA, Armstrong TJ, Foulke JA, Herrin GD, Rabourn RA, Ulin SS. Development and evaluation of an observational method for assessing repetition in hand tasks. *Am Ind Hyg Assoc J.* (1997) 58:278–85. doi: 10.1080/15428119791012793

10. Sala E, Torri D, Tomasi C, Apostoli P. Stima del rischio da sovraccarico biomeccanico all'arto superiore condotta, con l'impiego di più metodi di analisi, in diversi settori manifatturieri [Risk assessment for upper extremity work related muscoloskeletal disorders in different manufactures by applying six methods of ergonomic analysis]. *G Ital Med Lav Erg*on. (2010) 32:162–73.
11. Apostoli P, Sala E, Gullino A, Romano C. Analisi comparata dell'applicazione di quattro metodi per la valutazione del rischio biomeccanico per l'arto superiore [Comparative analysis of the use of 4 methods in the evaluation of the biomechanical risk to the upper limb]. *G Ital Med Lav Ergon.* (2004) 26:223–41.
12. Sala E, Bonfiglioli R, Fostinellil J, Tomasi C, Graziosi F, Violante FS, et al. Metodi di valutazione del rischio da sovraccarico biomeccanico all'apparato muscolo scheletrico a confronto: esperienza applicativa di dieci anni [Risk assessment comparison of biomechanical overloading of the musculoskeletal system: 10 years' applied experience]. *G Ital Med Lav Ergon.* (2014) 36:260–6.
13. Waters TR, Putz-Anderson V, Garg A, Fine LJ. Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics.* (1993) 36:749–76. doi: 10.1080/00140139308967940
14. Baracco A, BechisM, Spada S. *Nuovo manuale di ergonomia industriale*. Torino: CSAO (2019). p. 254–6.
15. Jones T, Kumar S. Comparison of ergonomic risk assessment output in four sawmill jobs. *Int J Occup Saf Ergon.* (2010) 16:105–11. doi: 10.1080/10803548.2010.11076834
16. Selye H. Stress and psychiatry. *Am J Psychiat.* (1956) 113:423–7. doi: 10.1176/ajp.113.5.423
17. INRS. Méthode de prévention des troubles musculosquelettiques du membre supérieur et outils simples. *Doc Med Trav.* (2000) 83:187-223.
18. Scarin S, Aspesi V, Malchiodi Albedi G, Cimolin V, Cau N, Galli S, et al. Slow versus traditional strength training in obese female participants: preliminary results. *Int J Rehab Res. Internationale Zeitschrift fur Rehabilitationsforschung. Revue internationale de recherches de readaptation.* (2019) 42:120–5. doi: 10.1097/MRR.0000000000000335
19. Davila VJ, Meltzer AJ, Hallbeck MS, Stone WM, Money SR. Physical discomfort, professional satisfaction, and burnout in vascular surgeons. *J Vasc Surg.* (2019) 70:913–20.e2. doi: 10.1016/j.jvs.2018.11.026
20. Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, et al. What low back pain is and why we need to pay attention. *Lancet.* (2018) 391:2356–67. doi: 10.1016/S0140-6736(18)30480-X
21. Koes BW, van Tulder M, Lin CW, Macedo LG, McAuley J, Maher C. An updated overview of clinical guidelines for the management of non-specific low back pain in primary care. *Eur Spine J.* (2010) 19:2075–94. doi: 10.1007/s00586-010-1502-y
22. Maimaiti N, Wang J, Jin X, Wang S, Qin D, He L, et al. Cervical musculoskeletal disorders and their relationships with personal and work-related factors among electronic assembly workers. *J Saf Res.* (2019) 71:79–85. doi: 10.1016/j.jsr.2019.09.018
23. Vargas-Prada S Coggon D. Psychological and psychosocial determinants of musculoskeletal pain and associated disability. *Best Pract Res Clin Rheumatol.* (2015) 29:374–90. doi: 10.1016/j.berh.2015.03.003
24. Veirman E, Van Ryckeghem D, De Paepe A, Kirtley OJ, Crombez G. Multidimensional screening for predicting pain problems in adults: a systematic review of screening tools and validation studies. *Pain Rep.* (2019) 4:e775. doi: 10.1097/PR9.0000000000000775
25. Sala E, Albini E, Borghesi S, Gullino A, Romano C, Apostoli P. Patologie muscoloscheletriche dell'arto superiore in addetti alla filatura: assenza di rischio o carenza di metodi per valutare in modo adeguato il rischio? [Work-related musculoskeletal disorders of the upper extremity in spinning: lack of risk or of adequate methods for assessing risk?]. *G Ital Med Lav Ergon.* (2005) 27:8–20.
26. Dahlqvist C, Nordander C, Forsman M, Enquist H. Self-recordings of upper arm elevation during cleaning - comparison between analyses using a simplified reference posture and a standard reference posture. *BMC Musculoskelet Disord.* (2018) 19:402. doi: 10.1186/s12891-018-2328-8
27. García-Vidal JA, López-Nicolás M, Sánchez-Sobrado AC, Escolar-Reina MP, Medina-Mirapeix F, Bernabeu-Mora R. The combination of different ergonomic supports during dental procedures reduces the muscle activity of the neck and shoulder. *J Clin Med.* (2019) 8:1230. doi: 10.3390/jcm8081230
28. Lenzi SE, Standoli CE, Andreoni G, Perego P, Lopomo NF. Comparison among standard method, dedicated toolbox and kinematic-based approach in assessing risk of developing upper limb musculoskeletal disorders. In*:* Ahram TZ, editor. *Advances in Human Factors in Wearable Technologies and Game Design.* Cham: Springer International Publishing (2019) p. 135–45.
29. Ranavolo A, Chini G, Silvetti A, Mari S, Serrao M, Draicchio F. Myoelectric manifestation of muscle fatigue in repetitive work detected by means of miniaturized sEMG sensors. *Int J Occup Saf Ergon.* (2018) 24:464–74. doi: 10.1080/10803548.2017.1357867
30. Standoli CE, Lenzi SE, Lopomo NF, Perego P, Andreoni G. Using digital human modeling to evaluate large scale retailers' furniture: two case studies. In: Cassenti DN, editor. *Advances in Human Factors in Simulation and Modeling.* Cham: Springer International Publishing (2019). p. 512–21.

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Burnout Among Private Security Staff in Serbia: A Multicentic Cross-Sectional Study

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Background: Burnout is a special a state of physical or emotional exhaustion that also involves a sense of reduced accomplishment and loss of personal identity.

Objectives: To evaluate the predictors of burnout among work staff in the seven private agencies for support and defense of persons and their property.

Material and Method: We performed a multicentric cross-sectional study that involved representative sample of working staff from Agencies of Private Security in Central Serbia. Burnout was assessed using Maslach Burnout Inventory- (MBI)-Human Services Survey.

Results: A total number of participants were 353 (330 men and 23 women). Measured level of burnout as assessed by high emotional exhaustion, high depersonalization, and low personal accomplishment was 66.3, 82.4, and 13.4%, respectively. We identified that female gender, younger age, shorter work experience, working in shifts, working 12 h a day and more than 8–12 h a day as well as dissatisfaction with working conditions. Work in shifts, working 12 h a day and more than 8–12 h a day and dissatisfied with dissatisfaction with working conditions significantly increase the risk of total burnout.

Conclusion: Our results showed that significant predictors for the development of burnout syndrome were female gender, younger age, shorter work experience, working in shifts, as well as dissatisfaction with working conditions.

Keywords: burnout, predictors, prevntion, working staff, MBI questionnaire

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INTRODUCTION

Burnout is a specific syndrome that is a consequence of prolonged exposal to occupational stress, and it is primarily specific for occupations featured by working with people in emotionally challenging situations (1). There is no standard definition of this syndrome, and the most often quoted is the one proposed by Maslach and Jakson (2) that defines burnout as "a psychological syndrome involving emotional exhaustion, depersonalization, and a diminished sense of personal accomplishment that occurred among various professionals who work with other people in challenging situations."

There is a lot of research on the burnout syndrome of police officers around the world (3–10), and the occupation of a police officer is undoubtedly one of the most stressful ones (11). In

addition to securing public order and peace and traffic regulation, similar work is also performed by employees who secure other people and their property.

For professional staff who provides security of individuals and their property and who needs to spend a lot of time in intensive interaction with the clients and focus on current issues, chronic stress can be emotionally draining and it poses a risk of "burnout." Burnout usually takes place about a year after a person starts working in an institution (12, 13). Three key aspects of the burnout syndrome are emotional exhaustion, depersonalization, and a diminished sense of personal accomplishment, which occur as a response to chronic stress at jobs related to direct working with people (14–17).

Emotional exhaustion relates to an individual's assessment that their emotional and physical strength is exhausted over the limits, and the symptoms often manifest as fatigue, headache, insomnia, and appetite disorder. The emotional exhaustion symptoms are central and they are accompanied by depersonalisation and a diminished sense of personal accomplishment (15, 16). Emotional exhaustion is featured by a sense of emotional overextension as a result of work; depersonalisation is featured by emotional indifference and dehumanization of service recipients, and the diminished sense of personal accomplishment is featured by the sense of professional stagnation, incapability, incompetence, and unfulfillment (17, 18).

Depersonalisation refers to the development of insensitive and cynical attitude toward people who are service recipients, negative attitude toward work, as well as the loss of sense of own identity. The diminished sense of personal accomplishment refers to negative self-assessment of competences and accomplishments at a workplace, and the symptoms are visible as a lack of motivation to work, decline in self-esteem and general productivity (14–17).

Due to professional stress and the arising burnout, the employees are at risk of clinical manifestations of depression, professional impairment, leaving work, alcohol and drugs abuse, suicide, and increased aggression toward others (7, 8). Burnout has serious professional and personal consequences, including lack of professionalism (often sick-leaves, reduced efficiency at work, lack of interest, non-collegiality) (19), and problems in communication with close persons, divorces, losing friends, alienation, aggressiveness privately (20, 21).

It is known that burnout occurs as a result of a complex interplay between individual-demographic risk factors and organizational factors (4). Several individual level factors, including external locus of control, poor self-esteem, and maladaptive coping styles, have been associated with burnout (17, 18).

Various studies have dealt with the research of external factors, and particularly with the so-called burnout external triggers such as the organizational structure and the effect of the social environment factors (14, 15, 19–22) dealing with the key issue—why in the same working conditions one employee experiences the burnout syndrome and the other does not.

The objective of the paper was to identify and analyse predictors for burnout among the staff who secures individuals and their property in Central Serbia.

MATERIALS AND METHODS

Study Design

The study was conducted in the population of Central Serbia, excluding the territory of Autonomous Province Vojvodina and Autonomous Province of Kosovo and Metohija. A multicentric cross-sectional study was applied that included staff employed at private security agencies in seven cities in Central Serbia. The study was conducted on a representative sample whose size was determined by https://www.statisticshowto.com/probability-and-statistics/find-sample-size/.

The representative sample size was 439, the study strength is 80% and type 1 error probability α of 0.05. The study included 353 questionnaires that were completely filled out.

The study was performed in the period from March 3, 2019 to April 30, 2019.

Study Inclusion Criteria

Adults 18–65 years of age, citizens of the Republic of Serbia, full-time employees, licensed to work in private security and working longer than 12 months.

Exclusion Criteria

Staff in the process of obtaining the license, discontinuity at work longer than 1 year, long-term sick leaves or multiple changes of workplace in the past 5 years, respondents recently exposed to major psychophysical trauma regardless of the professional environment (illness or death of a close person, divorce, etc.), refusal to participate in the research.

Questionnaires

An epidemiological questionnaire has been prepared to gather respondents' descriptive information and a specific questionnaire for burnout syndrome risk level assessment for representatives of service industries (Maslach Burnout Inventory—MBI-HSS), (18).

A semi-structural epidemiological questionnaire with 20 questions has been prepared, specially designed for this research, to gather the basic socio-demographic information (sex, age, marital status and number of children, level of education, length of service, work experience and length of service at any of the managerial positions, shift work, field work, specific features of a workplace).

One question on a three-point Likert scale examined the level of the respondents' satisfaction with the conditions of their work. The respondents were offered a possibility to present in an open question any complaints on the work conditions. Household financial status was assessed based on the housing status, amount of personal income and additional revenues.

The MBI-HSS questionnaire is an internationally accepted burnout measuring standard that measures 3 burnout dimensions and it is often used as a model for the evaluation of validity of other burnout risk assessment scales.

TABLE 1 | The limit values of the calculated subscales.

Emotional exhaustion		Depersonalisation		Personal accomplishment	
Level	**Value**	**Level**	**Value**	**Level**	**Value**
Low	0–16 points	Low	0–6 points	Low	0–31 points
Medium	17–26 points	Medium	7–12 points	Medium	32–38 points
High	27 points and more	High	13 points and more	High	39 points and more

MBI today is considered the most famous and most reliable measuring instrument for burnout syndrome measuring, which is supported by the fact that over 90% of implemented surveys have used this instrument (21). Maslach et al. have originally defined burnout as a psychological syndrome of emotional exhaustion, depersonalisation (later replaced with cynicism construct) and reduced effectiveness or personal accomplishment, which make this scale a multidimensional construct. We have used the questionnaire for staff employed at institutions who are in direct contact with people (Human Services Survey, MBI-HSS) with 22 variables.

MBI-HSS consists of the total of 22 questions that are afterwards used in the calculation of three subscales measuring different occupational burnout aspects:

1. Emotional exhaustion—measures the sense of emotional strain and exhaustion caused by work.
2. Depersonalisation—measures the inexistence of sense and impersonal reaction toward the recipient of services, help, treatment or tutoring, or a sense of discomfort caused by exertion.
3. Personal fulfillment or lack of personal accomplishment—measures the experience of competence and success in working with people, or a sense of competition and job satisfaction.

The Emotional Exhaustion (EE) subscale is made of 9 questions, the Depersonalisation (DP) scale is made of 5 questions and the Personal Accomplishment (PA) scale is made of 8 questions. Each question is made up of a series of statements expressing the degree of agreement with the expressed statements, and the response categories are provided through the 7-point Likert scale from 0 (never) to 6 (every day), or (0—never, 1—once a year or less, 2—once a month and less, 3—a few times a month, 4—once a week, 5—a few times a week, 6—every day).

The total score of each respondent was obtained by summing with a specific key the matrix for each of the three previously mentioned subscales, and the total degree of occupational burnout is represented by a comprehensive scale calculated based on a precise formula (18). The limit values of the calculated subscales are given in **Table 1**.

High level of burnout at work is reflected in high scores on the emotional exhaustion and depersonalisation subscales and low scores on the personal accomplishment subscale. This means that high scores on the EE and DP scales contribute to the burnout syndrome, while high scores on the professional accomplishment scale diminishes it (19).

Medium level of occupational burnout syndrome is a reflection of means on all scales.

Low level of burnout at work is reflected in low scores on the emotional exhaustion and depersonalisation subscales and high scores on the personal accomplishment subscale. We cannot make a conclusion about the presence of occupational burnout syndrome if only the PA subscale is observed. The PA scale is relevant only if confirmed with the EE or DP scale.

Licenses for the MBI-HSS questionnaire and the evaluation key, as well as the usage permission were obtained directly from the current license owners—from the SINAPSA EDITION Company according to license no. 2/2018 dated May 9, 2018.

The research was approved by the Ethics Committee of the Faculty of Medicine of the University of Pristina with temporary seat in Kosovska Mitrovica by the Decision No 09-972-1 dated September 10, 2018.

The managers of private security agencies provided written approvals for the research. All the respondents were informed in detail about the research and they signed the consents to participate in the study.

Statistical Analyses

All the analyses were done in the SPSS-ver. 22 program package. Data were presented as the mean and standard deviation (SD) or as frequencies and proportions. Linear univariate regression analysis was used to find association between assumed predictors. Statistically significant parameters were then included in the multivariate analysis. A multivariate regression analysis was applied to determine the most important predictors of burnout syndrome. The results are presented as Beta coefficients and its p-value. The p-value below 0.05 ($p < 0.05$) was considered statistically significant.

RESULTS

A total of 353 respondents (330–93.5% male and 23–6.5% female) participated in the research. The response rate was 80%. The average age of all the respondents was 43.62 ± 11.37. The average age of men was significantly higher than the age of women, 44.09 ± 11.44 vs. 36.91 ± 7.92 ($F = 8.752$; $p = 0.003$).

Basic socio-demographic characteristics and the length of service in regard to the gender structure of the respondents are presented in **Table 2**.

Men represent 93.5% of all the respondents; they were significantly older than women. More than 64.3% of the respondents were married; about one third did not have children 33.7%, and more than a half of the respondents had completed secondary school 54.7%. The least of the employed had a University degree 7.6%.

TABLE 2 | Basic socio-demographic characteristics and the length of service in regard to the sex distribution of the respondents.

Sociodemographic characteristics		Number percentage
Sex	Male	330 (93.5%)
	Female	23 (6.5%)
Marital status	Married	227 (64.3%)
	Unmarried	87 (24.6%)
	Extramarital union	12 (3.5%)
	Divorced	23 (6.5%)
	Widower/widow	4 (1.1%)
Number of children	None	119 (33.7%)
	One	84 (23.8%)
	Two	129 (36.5%)
	Three	20 (5.7%)
	More	1 (0.3%)
Education	Three years of high school	103 (29.2%)
	Four years of high school	193 (54.7%)
	High school–two and a half year studies	16 (4.5%)
	High school–three-year vocational or academic studies	14 (4.0%)
	Faculty–basics or master studies	27 (7.6%)
Workplace	Administrative worker	6 (1.7%)
	Director	8 (2.3%)
	Coordinator	3 (0.8%)
	Manager	5 (1.4%)
	Control center operator	20 (5.7%)
	Security officer	273 (77.3%)
	Boss of security service	38 (10.8%)
Work in shifts	Yes	288 (81.6%)
	No	65 (18.4%)
Work hours	Up to 8 h	36 (10.2%)
	8–12 h	277 (78.5%)
	More than 12 h	40 (11.3%)
Work conditions	Satisfied	225 (63.7%)
	Not satisfied nor dissatisfied	109 (30.9%)
	Dissatisfied	19 (5.4%)
Possession of weapons	Yes	115 (32.6%)
	No	238 (67.4%)
Housing issue	Owner of residential building in which I live	239 (67.7%)
	Owner of residential building for which I am paying rent for	15 (4.3%)
	Tenant	99 (28%)
Monthly income	Less than minimal wage	9 (2.5%)
	Minimal wage	252 (71.4%)
	Above minimal wage	92 (26.1%)
Additional income	Yes	109 (30.9%)
	No	244 (69.1%)

239 (67.7%) had a settled housing issue. More than 70% of the respondents were in the service and about 10% held managing positions. 81.6% of respondents worked in shifts, and most of the respondents—as much as 277 (78.5%) worked from 8 to 12 h.

More than 60% responded that they are satisfied with the working conditions: Approximately one third (32.6%) is armed at work. The biggest number of the respondents (71.4%) had monthly revenue at the level of a minimum average salary, and 30.9% of the respondents had additional income.

The average length of service of men was 18.43 ± 11.93 and it was significantly higher than the length of service of women 10.08 ± 7.27 years ($F = 10.969$; $p = 0.001$), are presented in **Table 3**.

Results of multivariate regression analysis in regard to the dependant EE variable are in **Table 4**.

Table 5 shows the results of DR scale modeling with the application of multivariate logistic regression analysis in regard to the independent variables as follows: gender, age, marital status, number of children, education, length of service, service in the company, shift work, working hours, managerial function, and working conditions.

The dependent variable "depersonalisation" was transformed into a binary type. The reference category is represented by low and moderate level of depersonalisation. The effect of dependent variables on the independent variable-level depersonalisation has not been determined.

The dependent variable "personal accomplishment" was transformed into a binary type. The reference category is represented by high and moderate level of PA. The gender of the respondents stood out as a significant variable in the dependent PA variable modeling. The cross-ratio of "male" in comparison to the reference category "female" amounts to 2,644 and the significance is at the level of 0.10, while its corresponding 90% confidence interval for the cross-ratio is 0.879−7.954. If a respondent is male, the probability that he will manifest the burnout syndrome in the form of lowered PA is reduced by 164% in comparison to female respondents.

The respondents' education also stood out as a significant variable in the dependent PA variable. The cross-ration of "college" education in comparison to the reference category of "secondary three-year school" amounts to 3.698 and the significance is at the level of 0.10, while its corresponding 90% confidence interval for the cross-ration amounts to 1.237–11.051. If a respondent has college education, the probability that they will manifest the burnout syndrome in the form of lowered PA is reduced by 269% in comparison to the respondents with 3-year secondary school.

Table 6 shows the results of PA subscale modeling with the application of multivariate logistic regression analysis in regard to the independent variables as follows: gender, age, marital status, number of children, education, length of service, service in the company, shift work, working hours, managerial function, and working conditions.

Table 7 shows the results of the dependent "total burnout" modeling with the application of multivariate logistic regression analysis in regard to the independent variables as follows: gender, age, marital status, number of children, education, length of

TABLE 3 | Influence of sex and length of service on the risk of occurance of burnout syndrome in the observed population.

Variable		*N*	X*	SD	SEM	95% C		Min	Max
						Lower	Upper		
Sex	Male	330	44.09	11.44	0.62	42.85	45.33	20.00	69.00
	Female	23	36.91	7.92	1.65	33.48	40.34	20.00	51.00
								***F* = 8.752; *p* = 0.003**	
Length of service	Male	330	18.43	11.93	0.65	17.14	19.73	1.00	49.00.0
	Female	23	10.08	7.27	1.51	6.94	13.23	1.00	23.00.0
								***F* = 10.969; *p* = 0.001**	

N, Number of responders.
X-average value.*

TABLE 4 | Factors affecting the EE variable: results of multiple regression analysis.

Characteristics		B	S.E.	Wald	df	Sig.	Exp (B)
Sex	Female	Reference value					
	Male	−1.285	0.630	4.16	1	0.041	0.277
Age		−0.039	0.010	13.70	1	0.000	0.962
Marital status	Married	Reference value					
	Unmarried	1.746	1.163	2.25	1	0.133	5.731
	Extramarital union	1.951	1.178	2.74	1	0.098	7.038
	Divorced	1.435	1.295	1.22	1	0.268	4.200
	Widower/widow	1.925	1.240	2.40	1	0.121	6.857
Number of children	None	Reference value					
	One	0.084	0.306	0.07	1	0.784	1.088
	Two	−0.128	0.268	0.22	1	0.632	0.880
	Three	−0.313	0.496	0.39	1	0.528	0.731
Education	Three years of high school	Reference value					
	Four years of high school	−0.057	0.255	0.05	1	0.822	0.944
	High school—two and a half year studies	0.477	0.613	0.60	1	0.436	1.612
	High school—3-year vocational or academic studies	0.295	0.627	0.22	1	0.638	1.343
	Faculty—basics or master studies	0.860	0.537	2.56	1	0.109	2.364
Length of service		−0.037	0.010	14.25	1	0.000	0.964
Length of service in company		−0.056	0.025	5.13	1	0.024	0.946
Work in shifts	No	Reference value					
	Yes	0.253	0.299	0.71	1	0.398	1.288
Work hours	Up to 8 h	Reference value					
	8–12 h	−0.432	0.405	1.13	1	0.286	0.649
	More than 12 h	−0.693	0.502	1.90	1	0.168	0.500
Management function	No	Reference value					
	Yes	−0.207	0.309	0.45	1	0.502	0.813
Work conditions	Satisfied	Reference value					
	Neither satisfied nor dissatisfied	−0.705	0.243	8.38	1	0.004	0.494
	Dissarisfied	−0.626	0.488	1.64	1	0.199	0.535

TABLE 5 | Factors affecting the DP variable: results of multiple regression analysis.

Characteristics		B	S.E.	Wald	df	Sig.	Exp (B)
Sex	Female	Reference value					
	Male	−0.373	0.636	0.344	1	0.558	0.689
Age		−0.011	0.012	0.832	1	0.362	0.989
Martial status	Married	Reference value					
	Unmarried	−0.083	0.328	0.064	1	0.801	0.921
	Extramarital union	0.037	0.794	0.002	1	0.963	1.037
	Divorced	−0.292	0.535	0.297	1	0.585	0.747
	Widower/widow						
Number of children	None	Reference value					
	One	0.461	0.414	1.241	1	0.265	1.586
	Two	−0.115	0.328	0.123	1	0.726	0.891
	Three	−0.693	0.544	1.624	1	0.203	0.500
Education	Three years of high school	Reference value					
	Four years of high school	−0.411	0.341	1.452	1	0.228	0.663
	High school—two and a half year studies	−0.383	0.702	0.298	1	0.585	0.682
	High school—3-year vocational or academic studies	−0.550	0.712	0.597	1	0.440	0.577
	Faculty—basics or master studies	−0.368	0.573	0.413	1	0.521	0.692
Length of service		−0.003	0.012	0.071	1	0.790	0.997
Length of service in company		−0.052	0.029	3.31	1	0.069	0.949
Work in shifts	No	Reference value					
	Yes	0.671	0.427	2.46	1	0.116	1.956
Work hours	Up to 8 h	Reference value					
	8–12 h	−0.336	0.506	0.440	1	0.507	0.715
	More than 12 h	−0.090	0.654	0.019	1	0.891	0.914
Management function	No	Reference value					
	Yes	0.048	0.396	0.015	1	0.904	1.049
Work conditions	Satisfied	Reference value					
	Not satisfied nor dissatisfied	−0.219	0.298	0.540	1	0.463	0.804
	Dissatisfied	0.547	0.768	0.506	1	0.477	1.727

service, service in the company, shift work, working hours, managerial function, and working conditions.

The dependent variable "total burnout" was transformed into a binary type. The reference category is represented by low and moderate level of total burnout.

A respondent who works in shifts has 75% increased probability to manifest the total burnout in comparison to respondents who do not work in shifts.

Respondents working 8–12 h have 150% greater probability to manifest the total burnout, and respondents working more than 12 h have 203% greater probability to manifest the total burnout.

A respondent who was not satisfied with the working conditions has 280% greater probability to manifest the total burnout in comparison to the respondents who are satisfied with the working conditions.

DISCUSSION

We have tested the factors that lead to the development of burnout syndrome in employees of privately-owned security agencies in Central Serbia. A multicentric cross-sectional study was applied which included a representative number of employees from seven privately-owned security agencies. Data was collected using specific MBI-HSS questionnaire.

According to the obtained results, younger age, female gender, shorter working experience, shift work, shifts longer than 12 h a day as well as 8–12 h shifts and dissatisfaction with working conditions were significant factors for the development of burnout syndrome in employees of private security agencies.

More than 90% of participants in our study were men. Women were significantly younger than men and had a significantly shorter work experience compared to men. More than 80%

TABLE 6 | Factors affecting the PA variable: results of multiple regression analysis.

Characteristics		B	S.E.	Wald	df	Sig.	Exp (B)
Sex	Female	Reference value					
	Male	0.972	0.562	2.993	1	0.084	2.644
Age		−0.003	0.010	0.121	1	0.728	0.997
Marital status	Married	Reference value					
	Unmarried	0.065	0.266	0.059	1	0.808	1.067
	Extramarital union	0.370	0.602	0.377	1	0.539	1.448
	Divorced	0.444	0.444	1.002	1	0.317	1.559
	Widower/widow	0.706	1.010	0.489	1	0.484	2.027
Number of children	None	Reference value					
	One	−0.124	0.300	0.170	1	0.680	0.884
	Two	−0.124	0.267	0.214	1	0.643	0.884
	Three	−0.050	0.506	0.010	1	0.922	0.952
Education	Three years of high school	Reference value					
	Four years of high school	0.049	0.263	0.035	1	0.852	1.050
	High school—two and a half year studies	1.308	0.559	5.482	1	0.019	3.698
	High school–3-year vocational or academic studies	0.797	0.575	1.919	1	0.166	2.219
	Faculty—basics or master studies	0.422	0.446	0.897	1	0.344	1.525
Length of service		−0.004	0.009	0.137	1	0.711	0.996
Length of service in company		0.017	0.025	0.491	1	0.484	1.018
Work in shifts	No	Reference value					
	Yes	0.124	0.293	0.179	1	0.672	1.132
Work hours	Up to 8 h	Reference value					
	8–12 h	0.234	0.383	0.374	1	0.541	1.264
	More than 12 h	−0.026	0.500	0.003	1	0.958	0.974
Management function	No	Reference value					
	Yes	0.257	0.306	0.704	1	0.401	1.293
Work conditions	Satisfied	Reference value					
	Neither satisfied nor dissatisfied	0.188	0.244	0.593	1	0.441	1.207
	Dissatisfied	0.628	0.481	1.705	1	0.192	1.874

of participants worked in shifts and almost the same number worked more than 8–12 h a day.

According to the results of multivariate analysis, the employees who worked in shifts had 75% more risk of burnout syndrome. The highest risk of developing burnout was observed in employees who worked 12 h a day as well as those who worked 8–12 h a day.

Two thirds of participants were satisfied with their working conditions and a little less than one third did not answer this question. The results of multivariate analysis showed that the employees who were not satisfied with the working conditions had a higher risk of developing burnout but the risk was also higher, by 50%, in employees who did not answer this question.

The results obtained by our study are in accordance with results in relevant literature (23, 24). According to the results of a study conducted in Brazil, young employers with lower level of education and shorter length of service had bigger emotional stress at work and higher EE, and the length of service and age were indicated as significant predictors of the total syndrome. Educated individuals with more work experience have more self-confidence in the performance of their duties; they show greater self-control in contact with various stressors and experience less emotional trauma (10).

Results from meta-analysis showed gender differences in burnout across a wide range of occupations found that women reported significantly higher levels of emotional exhaustion ($k = 199$, $d = 0.09$), and men reported significantly higher levels of depersonalization ($k = 184$, $d = -0.19$) (25). Meta-analytic results have also indicated a negative relationship between age and emotional exhaustion ($k = 34$, $r = -0.16$) (23).

TABLE 7 | Factors affecting the Total Burnout: results of multiple regression analysis.

Characteristics		B	S.E.	Wald	df	Sig.	Exp (B)
Sex	Female	Reference value					
	Male	−1.195	0.751	2.532	1	0.112	0.303
Age		0.006	0.011	0.254	1	0.614	1.006
Marital status	Married	Reference value					
	Unmarried	0.130	0.293	0.198	1	0.657	1.139
	Extramarital union	0.115	0.685	0.028	1	0.867	1.122
	Divorced	−1.138	0.757	2.261	1	0.133	0.321
	Widower/widow	1.214	1.012	1.437	1	0.231	3.365
Number of children	None	Reference value					
	One	−0.303	0.350	0.750	1	0.386	0.738
	Two	0.035	0.295	0.014	1	0.907	1.035
	Three	−0.243	0.598	0.165	1	0.685	0.784
Education	Three years of high school	Reference value					
	Four years of high school	0.027	0.292	0.008	1	0.927	1.027
	High school—two and a half year studies	0.148	0.624	0.056	1	0.813	1.159
	High school—3-year vocational or academic studies	−0.053	0.693	0.006	1	0.939	0.949
	Faculty—basics or master studies	0.197	0.499	0.156	1	0.693	1.217
Length of service		0.005	0.011	0.244	1	0.621	1.005
Length of service in company		0.021	0.028	0.565	1	0.452	1.021
Work in shifts	No	Reference value					
	Yes	−1.386	0.310	19.98	1	0.000	0.250
Work hours	Up to 8 h	Reference value					
	8–12 h	0.917	0.549	2.794	1	0.095	2.502
	More than 12 h	1.110	0.638	3.030	1	0.082	3.034
Management function	No	Reference value					
	Yes	−0.020	0.356	0.003	1	0.954	0.980
Work conditions	Satisfied	Reference value					
	Neither satisfied nor dissatisfied	0.428	0.275	2.420	1	0.120	1.534
	Dissatisfied	1.337	0.490	7.457	1	0.006	3.809

In our study, sex and education level were significant factors which impacted the PA scale. Men and those employees who had higher education level had a lower risk of feeling unfulfilled, compared to women and employees who graduated from a 3-year high school. Our results are in agreement with the other literature data (10, 23–25).

Considering the scores of each subscale, we have noticed a significant burnout syndrome level among professional staff who provides security of individuals and their property in private Agencies in Central Serbia.

86.1% of respondents had high and moderate EE levels. The largest number of the respondents had high DP levels—82.4%, 16.1% of respondents had moderate levels while 1.4% of respondents had low DP levels.

According to Maslach theory, EE has had the greatest prevalence in surveys (2) as well as in our study. Similar findings can find in paper of other authors (25–27).

In our study, 34.6% of participants had low levels of PA, 32.9% had moderate levels and 32.6% had high levels of PA. Our results are in accordance with results in relevant literature (26, 27).

According to Mastracci et al. use-of-force is a workplace stressor (27). Less than a third of our participants were obliged to carry a weapon at the work place and this was not a significant factor for the development of burnout syndrome. However, different results are available in literature.

Results of a study performed in the professional military personnel of Serbian Armed Forces (28) showed that the highest level of burnout was measured on the subscales Emotional

exhaustion (EE) in military personnel aged 23–30 years of age ($p < 0.05$) and anxiety increased with age ($p < 0.001$). Total scores on the subscales EE and DP increased, while on the subscale PA decreased with the increase of the total score of Back Anxiety Inventory Scale ($p < 0.001$).

CONCLUSION

Burnout can be response to chronic job stress for working staff in seven private agencies for security in Central Serbia. According to the results obtained in our study, the most significant factors for the development of burnout syndrome were female gender, younger age, shorter work experience, working in shifts, working 12 h a day, and more than 8–12 h a day as well as dissatisfaction with working conditions. 86.1% of respondents had high and moderate Emotional Exhaustion levels. The largest number of the respondents had high Depersonalisation levels−82.4%, 16.1% of respondents had moderate levels while 1.4% of respondents had low levels. Factors that significantly reduce probability that working staff will manifest the burnout syndrome in the form of lowered Personal Accomplishment level were male sex and "college"-University education. The results of the study indicate that further studies are needed among professional staff who provide security of individuals and their property in private Agencies in Central Serbia.

The Strength of the Study Are

This was the first study among professional staff who provide security of individuals and their property in private Agencies in Central Serbia and it was conducted on the representative sample of employees in seven sities. The study named the most important predictors for **burnout syndrome and showed that there is a place for preventive.**

Our Study Has Some Limitations

There were a small number of women in our sample, because in our country, yet, a small number of women work this job. We couldn't include employees from private agencies from the two provinces, because we didn't get official permissions.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Ethics Committee of the Faculty of Medicine of the University of Pristina with temporary seat in Kosovska Mitrovica by the Decision No 09-972-1 dated September 10, 2018. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

DV wrote the manuscript, organized data base, and did investigation. NR performed statistical analysis. MRM, NR, and LK contribute to conception and design of the study. DV, VS, DI, and MS did the investigation. LS, MVM, and SMĐ wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

REFERENCES

1. Schaufeli WB, Buunk BP. Burnout: an overview of 25 years of research in theorizing. In: Schabracq MJ, Winnubst JAM, Cooper CL, editors. *The Handbook of Work and Health Psychology*. Chichester: Wiley (2003). p. 383–425. doi: 10.1002/0470013400.ch19
2. Maslach C, Jakson SE. The measurement of experienced burnout. *J Occup Behav*. (1981) 2:99–113. doi: 10.1002/job.4030020205
3. Adams I, Mastracci S. Police body-worn cameras: effects on officers' burnout and perceived organizational support. *Police Q*. (2019) 22:5–30. doi: 10.1177/1098611118783987
4. Aguayo R, Vargas C, Cañadas GR, Fuente EI. Are sociodemographic factors associated to burnout syndrome in police officers? A correlational meta-analysis. *An Psicol*. (2017) 33. 383–92. doi: 10.6018/analesps.33.2.260391
5. Ranta RS, Sud A. Management of stress and burnout of police personnel. *JIAAP*. (2008) 34:29–39. doi: 10.4172/2329-6488.1000244
6. Burke RJ. Stressful events, work-family conflict, coping, psychological burnout, and well-being among police officers. *Psychol Rep*. (1994) 75:787–800. doi: 10.2466/pr0.1994.75.2.787
7. Violanti JM, Owens SL, Fekedulegn D, Ma CC, Charles LE, Andrew ME, et al. An exploration of shift work, fatigue, and gender among police officers: the BCOPS study. *Workplace Health Saf*. (2018) 66:530–37. doi: 10.1177/2165079918754586
8. Violanti JM, Owens SL, Mc Canlies E, Fekedulegn D, Andrew ME. Law enforcement suicide: a review. *Policing*. (2019) 42:141–64. doi: 10.1108/PIJPSM-05-2017-0061
9. Burke RJ, Mikkelsen A. Burnout among norwegian police officers: potential antecedents and consequences. *Int J Stress Manag*. (2006) 13:64–83. doi: 10.1037/1072-5245.13.1.64
10. Castro MC, Rocha R, Cruz R. Mental health of the Brazilian police policy: theoretical-methodological trends. *Psicol Saúde Doença*. (2019) 20:525–41. doi: 10.15309/19psd200220
11. Costa T, Passos F, Queirós, C. Suicides of male Portuguese police officers – 10 years of national data. *Crisis*. (2019) 40:360–4. doi: 10.1027/0227-5910/a000570
12. Schaible LM, Gecas V. The impact of emotional labor and value dissonance on burnout among police officers. *Police Q*. (2010) 13:316–41. doi: 10.1177/1098611110373997
13. Maslach C, Leiter MP. Understanding burnout. *Handb Stress Health*. (2017) 51:36–56. doi: 10.1002/9781118993811.ch3
14. Hobfoll SE. Conservation of resources: a new attempt at conceptualizing stress. *Am Psychol*. (1989) 44:513–24. doi: 10.1037/0003-066X.44.3.513
15. Maslach C, Jackson SE. The role of sex and family variables in burnout. *Sex Roles*. (1985) 12:837–51. doi: 10.1007/BF00287876
16. Schaufeli WB. Burnout: a short socio-cultural history. In: Neckel S, Schaffner AK, Wagner G, editors. *Burnout, Fatigue, Exhaustion: An Interdisciplinary Perspective on a Modern Affliction*. London: Palgrave Macmillan (2017). p. 105–27. doi: 10.1007/978-3-319-52887-8_5

17. Schaufeli WB, Leiter MP, Maslach C. Maslach burnout inventory–general survey. In: Maslach C, Jackson SE, Leiter MP, editors. *The Maslach Burnout Inventory—Test manual (3rd ed.)*. Palo Alto, CA: Consulting Psychologists Press (1996).
18. Maslach C, Leiter MP, Schaufeli WB. Measuring burnout. In: Cooper CL, Cartwright S, editors. *The Oxford Handbook of Organizational Wellbeing*. Oxford: Oxford University Press (2008). doi: 10.1093/oxfordhb/9780199211913.003.0005
19. Brenninkmeije V, VanYperen N. How to conduct research on burnout: advantages and disadvantages of a unidimensional approach in burnout research. *Occup Environ Med.* (2003) 60 (Suppl. 1):i16–20. doi: 10.1136/oem.60.suppl_1.i16
20. Green AA, Brian JD, Albanese BA, Shapiro MN, Aarons GA. The roles of individual and organizational factors in burnout among community-based mental health service providers. *Psychol Serv.* (2014) 11:41–9. doi: 10.1037/a0035299
21. Maslach C, Jackson SE, Leiter, M. *Maslach Burnout Inventory*. 3rd ed. Palo Alto, CA: Consulting Psychologists Press (1996).
22. Nonnis M, Massidda D, Cuccu S, Cortese CG. The impact of workaholism on nurses' burnout and disillusion. *Open Psychol J.* (2018) 11:77–8. doi: 10.2174/1874350101811010077
23. Purvanova RK, Muros JP. Gender differences in burnout: a meta-analysis. *J Vocat Behav.* (2010) 77:168–85. doi: 10.1016/j.jvb.2010.04.006
24. Brewer EW, Shapard L. Employee burnout: a meta-analysis of the relationship between age or years of experience. *Hum Resour Dev Rev.* (2004) 3:102–23. doi: 10.1177/1534484304263335
25. Maslach C, Schaufeli WB, Leiter MP. Job burnout. *Ann Revue Psychol.* (2001) 52:397–422. doi: 10.1146/annurev.psych.52.1.397
26. Milenović M, Matejić B, Vasić V, Frost E, Petrović N, Simić D, et al. High rate of burnout among anaesthesiologists in Belgrade teaching hospitals: results of a cross-sectional survey. *Eur J Anaesthesiol.* (2016) 33:187–94. doi: 10.1097/EJA.0000000000000383
27. Mastracci SH, Adams IT. It's not depersonalization, It's emotional labor: examining surface acting use-of-force with evidence from the US. *Int J Law Crime Just.* (2019) 61:100358. doi: 10.1016/j.ijlcj.2019.100358
28. Vojvodic A, Dedic G. Correlation between burnout syndrome and anxiety in military personnel. *Ser J Exp Clin Res.* (2020) 21:59–65. doi: 10.2478/sjecr-2018-0004

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CASE REPORT
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Case Report: Occupation Radiation Disease, Skin Injury, and Leukemia After Accidental Radiation Exposure

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Objective: Follow-up observation of radiation accident in which a worker developed acute radiation disease and eventually died of leukemia. The case provided key practical information for the study on clinical effects of radiation on the health of workers.

Case Presentation: We observed and followed-up the progression and effect of radiation exposure at various stages in a 28-year-old male patient. We examined the chromosomal morphology, white blood cell count, and sperm count. Laboratory tests for leukemia diagnosis and other clinical parameters were performed.

Results: After the patient was irradiated, the white blood cell level decreased, the sperm count dropped to 0, and the libido completely disappeared. The patient's chromosome aberration cell rate and total chromosome aberration cell rate were 7.33 and 7.66%, respectively. Examination of leukemia diagnostic experiments revealed that abnormal cells accounted for 60%; bone marrow examination showed that prolymphocytes abnormally proliferated, accounting for 89%, and had positive extracellular iron staining. After the initial treatment, the patient's white blood cell level increased and was finally maintained at a normal level, the sperm count returned to normal levels, and libido was restored. The patient died of acute lymphoblastic leukemia 34 years after the exposure.

Conclusion: More attention has been paid to the long-term effects of ionizing radiation-induced malignant tumors. The occupational protection of radiographic inspection workers should be strengthened to reduce and avoid occupational injuries to protect the health and safety of workers.

Keywords: ionizing radiation, acute radiation disease, radioactive tumor, leukemia, case report

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INTRODUCTION

Application of ionizing radiation to an organism can produce biological effects of radiation on the organism (1). The mechanism of action can be divided into stochastic effect and deterministic effect, also called organizational response. Stochastic effects include cancers in exposed individuals due to somatic cell mutations and genetic effects in offspring due to germ cell mutations. Ionizing radiation induces malignant tumors, which has been confirmed in a large number of animal experiments and human epidemiological studies (2). However, the genetic effect induced by

ionizing radiation is still lacking epidemiological evidence, and such effect has only been found in animal experiments (2). Leukopenia, cataracts, erythema depilation, and other radiation skin damages caused by ionizing radiation are all deterministic effects. In 1978, an X-ray inspection worker in Zhejiang Province, China, was accidentally exposed to an uneven systemic irradiation, resulting in acute radiation disease of the bone marrow combined with local acute radiation skin injury. Thirty-four years after the accident, the patient died of acute lymphoblastic leukemia. The case is reported as follows.

CASE PRESENTATION

Occupational Exposure History

A male patient born in February 1950 began work with the X-ray inspection of metal parts in 1974. In the middle of the night on December 1978, he slept at the back of the X-ray flaw detector without knowing that his colleague had started up the industrial flaw detector compartment in the operating room. The exposure time was about 30 min. After the accident site simulation, the physical dose was estimated using LiF thermoluminescence dosimeter. When exposed to light from the 2005 X-ray flaw detector produced by Shanghai Flaw Detector Factory, with a maximum capacity of 7.5 kVA, the working voltage of the normal flaw detection operation was 160 kV. The average absorbed dose rate was 0.87 Gy/min at 0 m away from the probe window (close to the probe mirror); the absorbed dose of his back skin measured by the thermoluminescence dosimeter was 26.0 Gy. The dose-effect estimation curve of chromosome aberration (3) established in our laboratory was used to estimate the systemic absorbed dose of 1.78 Gy by chromosome aberration analysis of peripheral blood lymphocytes.

Clinical Manifestations

The patient developed nausea and vomiting once (4 h after exposure) and then had initial reactions such as generalized fatigue, dizziness, insomnia, dreaminess, and decreased appetite. Fifteen days after exposure, blisters appeared on the right side of the 6–10 thoracic vertebrae on the back, which developed from spot-like to large flaps (7 × 8 cm, equivalent to the radiation outlet of the detector probe). In addition, blisters appeared on the skin from the third intercostal to the junction of sternal body, and white scars left after 22 days; the blisters busted and formed ulcers. Furthermore, his sexual desire was significantly reduced. However, within 60 days after irradiation, there was no obvious infection or bleeding in the whole body except at the site of the radiation ulcer.

Nineteen months after irradiation, the patient was hospitalized for 1 month. After active symptomatic and supportive treatment, his general condition improved; however, the ulcers on his back did not heal. The local skin remained unhealed with conservative treatment for 3 years after exposure. In the third year, skin grafting was performed and the ulcer healed. Follow-up observation for 30 years showed no local skin ulceration or cancer. The patient was hospitalized in February 2012 (nearly 34 years after the exposure) with symptoms of dizziness, fatigue, chest tightness, and shortness of breath without obvious inducement. After comprehensive examination and analysis, the patient was clinically diagnosed with acute lymphocytic leukemia (L2 type with POSITIVE CD13/CD33). After two rounds of chemotherapy, the patient died of pulmonary infection due to bone marrow suppression on April 15.

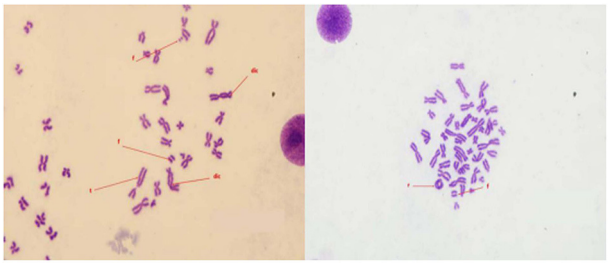

FIGURE 1 | Image of chromosome aberration (Fragment [F], Translocation [T], Dicentric [dic], Centric ring [r]).

Laboratory Examination

The patient's white blood cells decreased to 1.5 × 10^9/L, 20 days after exposure and fluctuated between (1.5 and 2.4) × 10^9/L for 18 months. Thus, the patient was hospitalized 19 months after exposure and treated with drugs to improve the leukocyte count, which increased to (4.2–5.4) × 10^9/L. Follow-up observation showed that the white blood cells remained at the normal level. The patient's early bone marrow smear examination showed granulocyte maturation disorder but normal hematopoietic function was restored after 2 years. Eighteen months after exposure, chromosomal aberration analysis of 600 cells in the patient showed 31 double centromeres, 5 translocations, 5 centromeres, 13 pairs of microsomes, and 13 pairs of fragments, as shown in **Figure 1**. In the detection of chromosome aberration in peripheral blood lymphocytes, the rate of chromosome aberration at 18 months, 5, 10, 20, and 34 years after exposure was 7.3, 5.5, 0.5, 0.5, and 0%, respectively. The semen examination of the patient showed that his sperm count was 0 within 18 months after the irradiation, and sexual desire completely disappeared; at the 24th month, his sperm count was 0–1/ml; and after 26 months, his sperm count returned to the normal level, and sexual desire resumed, as shown in **Table 1**. In the same year, his wife became pregnant and gave birth to a normal baby girl. Follow-up observation showed that the baby girl developed well.

Leukemia diagnostic test was performed and the results of blood routine showed that white blood cells (7.0 × 10^9/L), hemoglobin (75 g/L), platelets (10 × 10^9/L), and abnormal cells were 60%. Furthermore, bone marrow examination showed abnormal proliferation of proto-lymphocytes (89%) and positive extracellular iron staining, as shown in **Figure 2**. The immune types of leukemia were $CD7^+$, $CD13^+$, $CD33^+$, $CD34^+$, $CD38^+$, $CD45^+$, and $CD117^+$. The original T-lymphocyte population accounted for 81.13% of non-erythroid. No abnormality was found in the karyotype analysis of bone marrow cells. Qualitative tests for the c-KIT/D816V gene mutation, CEBPA gene mutation, and fusion gene screening were all negative.

TABLE 1 | Cell rate of semen and chromosome aberration at different times after irradiation.

	18 months	24 months	26 months	5 years	10 years	20 years	34 years
Sperm count (10,000/ml)	0	0–0.0001	4,600	8,400	7,600	6,800	7,100
Chromosome aberration† Cell rate (%)	7.33			5.5	0.5	0.5	0
Total chromosome† Aberration cell rate (%)	7.66			6.0	1.0	0.5	0

† *chromosome aberration tests were not performed at 24 and 26 months after the exposure.*

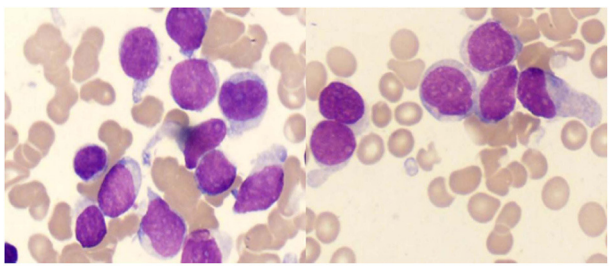

FIGURE 2 | Image of the bone marrow in acute lymphoblastic leukemia.

No obvious abnormalities were found in biochemical indexes, tumor markers, B-mode ultrasound, and CT (Computed Tomography) examination.

Calculation of the Probability of Tumor Causation

According to the current Standard for the Judgment of Occupational Radiation Tumors (GBZ 97-2017) (4), this case of malignant tumor has been included in the list of malignant tumors calculated in Table B.1 in Appendix B to calculate the probability of etiology. According to the patient's gender, the systemic absorbed dose of acute X-ray radiation at age 28 years was 1.78 Gy. After 34 years (62 years old), considering the diagnosis of acute lymphocytic leukemia and other data, the calculated PC (Probability of causation) value of the cause of cancer was 81%. The PC 95% upper limit was 200.88%, the adjusted PC' 95% upper limit was 144.93%, and the calculated 95% credible upper limit of etiology probability was $>$ 50%, which can be judged as occupational radiation tumor.

Cases of Diagnosis

Combined with the initial clinical manifestations, laboratory examination, dose estimation, and other data, the patient was diagnosed as acute radiation skin injury grade IV with mild systemic myeloid acute radiation disease. Moreover, 34 years after the exposure, the patient was diagnosed with acute lymphoblastic leukemia caused by excessive exposure to ionizing radiation.

DISCUSSION

The accidental irradiation caused the patient to receive a dose of 1.78 Gy. According to the national standard Diagnosis of Acute Radiation Sickness of Occupational External Radiation (GBZ 104-2017), although the white blood cells once dropped to 1.5×10^9/L after exposure, but combined with clinical manifestations, there were no multiple vomiting and only one vomiting in the early stage, with nausea, fatigue, decreased appetite, dizziness, headache, insomnia, and other symptoms. There were no typical symptoms of fever, infection, or bleeding at the extreme stage; therefore, the patient was eventually diagnosed with mild bone marrow acute radiation disease. The leucocytopenia in this case lasted for 19 months, which may be related to the delayed leucocytopenia caused by a large skin ulcer on the back that worsened the systemic condition and delayed the recovery of white blood cells. The impact of the recovery of fertility after the exposure on the offspring is a matter of concern (5). This patient's sperm count returned to normal and he became fertile 26 months after the exposure.

Although radiation does not play a prominent role in the etiology of all human cancers like chemical carcinogens, but since nuclear technology is more and more widely used in human production and life, the potential harm of radiation to humans is also increasing (6). The proportion of radioactive tumor in occupational radiation disease is increasing year by year. Due to the high incidence of radiation-induced leukemia and a long incubation period, it is receiving increasing attention (7). Radiation-induced leukemia was first reported in Japan. The leukemia started about 2 years after the exposure and reached its peak 6–8 years after the exposure. Among the various types of leukemia induced, acute granulocytes, lymphocytic leukemia, and chronic myelogenous leukemia were the major ones (7, 8). Leukemia is one of the earliest cancer effects after acute exposure to relatively high doses of ionizing radiation (9). This case was caused by uneven radiation of the whole body, resulting in local radioactive skin damage of grade IV with mild bone marrow acute radiation sickness. In our case, acute lymphocytic leukemia was diagnosed 34 years after the exposure. To calculate the cause of cancer caused by the previous exposure, the upper limit of 95% confidence limit of PC after correction was 144.93%.

This patient developed leukemia 34 years after the exposure and experienced a long incubation period. The pathogenesis of leukemia may be different from that of total body irradiation. The skin of the patient's back was close to the X-ray detector

probe for 30 min and was subjected to a large dose of local irradiation, resulting in penetrating injury from the skin of the back to the skin of the front chest. This resulted in local skin damage, as well as damage to the internal organs and hematopoietic tissues at the site. The gene mutation and chromosome aberration caused by DNA damage induced by ionizing radiation aggravated the instability of the cell genome that led to the loss of the normal growth regulation function of cells and promoted the malignant transformation of cells (10). Relevant studies have shown that ionizing radiation can lead to cluster damage of DNA molecules and generate secondary DNA damage with the action of free radicals, which is difficult to repair, has a high error repair rate, and produces far-reaching biological effects (11, 12). The induction of chromosomal aberrations in human lymphocytes exposed to ionizing radiation provides a commonly used and quantifiable biological dosimeter that can reliably estimate the radiation dose to which people are exposed (13). In this case, chromosome aberration in peripheral blood lymphocytes was still detected within 20 years of follow-up after the exposure, and the distortion rate was maintained at 0.5%. The authors believe that regular medical follow-up is necessary for patients with acute radiation disease, especially for patients with continuous positive chromosome aberrations, and the possibility from aberrations and mutations to canceration cannot be ruled out. At the same time, in order to prevent the occurrence of similar accidents, radiological protection rules and regulations should be strictly observed in the workplace, to enhance the awareness of personal protection. Workers using radiographic detection should wear personal alarm devices, to detect accidental exposures in time, reduce and avoid occupational injuries, and protect the health and safety of workers.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Institutional Ethics Committee of the First Affiliated Hospital of Zhejiang University School of Medicine. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

ZX directed the writing and revision of the paper. SG and XW conceived ideas. XH conducted the analysis and wrote the manuscript in collaboration with AY and SY. JG, QN, ZL, and YZ provided the feedback and suggestions. All authors read the manuscript and agreed to submit it.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.657564/full#supplementary-material

REFERENCES

1. Dmytrenko IV, Fedorenko VG, Shlyakhtychenko TY, Sholoyko VV, Lyubarets TF, Malinkina TV, et al. The efficiency of tyrosine kinase inhibitor therapy in patients with chronic myeloid leukemia exposed to ionizing radiation due to the Chornoby nuclear power plant accident. *Probl Radiac Med Radiobiol.* (2014) 19:241–55.
2. Trott KR. Biological mechanisms of radiation carcinogenesis. *Eur J Cancer Prev.* (1996) 5:377–8.
3. Balajee AS, Sanders JT, Golloshi R, Shuryak I, McCord RP, Dainiak N. Investigation of spatial organization of chromosome territories in chromosome exchange aberrations after ionizing radiation exposure. *Health Phys.* (2018) 115:77–89. doi: 10.1097/HP.0000000000000840
4. National Health and Family Planning Commission of the People's Republic of China. *GBZ 97-2017 Radiological Criteria for the Cause of Radiation Oncology*. Available online at: http://www.nhc.gov.cn/wjw/pcrb/201706/7a1f314cd0de4abdafe94446f593e329.shtml (accessed July 13, 2020).
5. Kesari KK, Agarwal A, Henkel R. Radiations and male fertility. *Reprod Biol Endocrinol.* (2018) 16:118. doi: 10.1186/s12958-018-0431-1
6. Wang FR, Fang QQ, Tang WM, et al. Nested case-control study of occupational radiation exposure and breast and esophagus cancer risk among medical diagnostic X ray workers in jiangsu of China. *Asian Pac J Cancer Prev.* (2015) 16:4699–704. doi: 10.7314/APJCP.2015.16.11.4699
7. Little MP, Weiss HA, Boice JD Jr, Darby SC, Day NE, Muirhead CR. Risks of leukemia in Japanese atomic bomb survivors, in women treated for cervical cancer, and in patients treated for ankylosing spondylitis. *Radiat Res.* (1999) 152:280–92. doi: 10.2307/3580328
8. Preston DL, Kusumi S, Tomonaga M, Izumi S, Ron E, Kuramoto A, et al. Cancer incidence in atomic bomb survivors. Part III. Leukemia, lymphoma and multiple myeloma, 1950-1987. *Radiat Res.* (1994) 137:S68–97. doi: 10.2307/3578893
9. Metz-Flamant C, Samson E, Caer-Lorho S, Acker A, Laurier D. Leukemia risk associated with chronic external exposure to ionizing radiation in a French cohort of nuclear workers. *Radiat Res.* (2012) 178:489–98. doi: 10.1667/RR2822.1
10. Little JB, Nagasawa H, Pfenning T, Vetrovs H. Radiation-induced genomic instability: delayed mutagenic and cytogenetic effects of X rays and alpha particles. *Radiat Res.* (1997) 148:299–307. doi: 10.2307/3579514
11. Goodhead DT. Initial events in the cellular effects of ionizing radiations: clustered damage in DNA. *Int J Radiat Biol.* (1994) 65:7–17. doi: 10.1080/09553009414550021
12. Rigaud O, Laquerbe A, Moustacchi E. DNA sequence analysis of HPRT-mutants induced in human lymphoblastoid cells adapted to ionizing radiation. *Radiat Res.* (1995) 144:181–9. doi: 10.2307/3579257

13. Wolff S. Biological dosimetry with cytogenetic endpoints. *Prog Clin Biol Res.* (1991) 372:351–62.

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BRIEF RESEARCH REPORT
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SARS-CoV-2 Infection in Healthcare Professionals and General Population During "First Wave" of COVID-19 Pandemic: A Cross-Sectional Study Conducted in Sicily, Italy

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On December 31, 2019, an outbreak of lower respiratory infections was documented in Wuhan caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Since the beginning, SARS-CoV-2 has caused many infections among healthcare workers (HCWs) worldwide. Aims of this study were: a. to compare the distribution among the HCWs and the general population of SARS-CoV-2 infections in Western Sicily and Italy; b. to describe the characteristics of HCWs infected with SARS-CoV-2 in the western Sicilian healthcare context during the first wave of the epidemic diffusion in Italy. Incidence and mean age of HCWs infected with SARS-CoV-2 were comparable in Western Sicily and in the whole Italian country. The 97.6% of infections occurred in HCWs operating in non-coronavirus disease 2019 (COVID-19) working environments, while an equal distribution of cases between hospital and primary care services context was documented. Nurses and healthcare assistants, followed by physicians, were the categories more frequently infected by SARS-CoV-2. The present study suggests that healthcare workers are easily infected compared to the general population but that often infection could equally occur in hospital and non-hospital settings. Safety of HCWs in counteracting the COVID-19 pandemic must be strengthened in hospital [adequate provision of personal protective equipment (PPE), optimization of human resources, implementation of closed and independent groups of HCWs, creation of traffic control building and dedicated areas in every healthcare context] and non-hospital settings (influenza vaccination, adequate psychophysical support, including refreshments during working shifts, adequate rest, and family support).

Keywords: SARS-CoV-2 infection, COVID-19, healthcare workers, personal protective equipment, traffic control building, influenza vaccination, psycho-physical support

INTRODUCTION

On December 31, 2019, an outbreak of unexplained lower respiratory infections was documented in Wuhan, the largest metropolitan area in China's Hubei Province, and reported for the first time to the WHO National Office in China (1). The etiology of this disease was attributed to a new virus belonging to the family of coronaviruses (CoVs), renamed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (2).

Previous outbreaks of CoV have been documented in the past, such as severe acute respiratory syndrome renamed coronavirus (SARS-CoV-1) in 2002/2003 and Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012 (3).

In early March 2020, the new virus demonstrated high contagiousness, and its worldwide spread has reached the epidemiological criteria necessary to be declared a pandemic (4). To date, about 73 million cases of SARS-CoV-2 infection and more than 1.6 million deaths due to coronavirus disease 2019 (COVID-19) have been observed worldwide (4).

In the last months, in Europe, there has been an epidemiological transition of the SARS-CoV-2 epidemic, with a sharp drop to 43 years in the average age of the population contracting the infection (5, 6).

Virus circulation occurs more frequently in younger age groups due to a greater reopening of commercial activities (including meeting places) and greater mobility, and this variation in transmission dynamics (with the onset of cases and outbreaks linked to recreational activities) was recently confirmed by epidemiological data supporting the evidence of the occurrence of a possible second wave of the pandemic (6).

SARS-CoV-2 has also caused many infections among healthcare workers (HCWs) worldwide (7). The Chinese National Health Commission stated that more than 3,300 health workers nationwide had been infected, and many of them died during the first epidemic wave that occurred in China (8).

HCWs are particularly vulnerable compared to the general population, as demonstrated by the continuous increase in cases, because the coronavirus is highly contagious and members of medical staff are increasingly exposed to viral particles, while often not being provided with adequate protective equipment (9). In addition, a combination of stress, long working hours, and night work could make their immune system more vulnerable than normal (10–13).

In addition, the Commission Directive (EU) 2020/739 included SARS-CoV-2 in the list of biological agents known to infect humans and amending Commission Directive (EU) 2019/1833 (14).

In Italy, to date, more than 80,000 HCWs have been infected with SARS-CoV-2 and hundreds have died due to COVID-19 (6).

Aims of this observational study were to compare the distribution among the HCWs and the general population of SARS-CoV-2 infection cases that occurred in Western Sicily and Italy and to describe the main characteristics of HCWs infected with SARS-CoV-2 in the western Sicilian healthcare context during the first wave of the SARS-CoV-2 epidemic diffusion in Italy. This analysis could contribute to investigate any differences of SARS-CoV-2 infection incidence according to health care setting, professional role, or working environment.

MATERIALS AND METHODS

A cross-sectional study was conducted in Western Sicily, to date, a COVID-19 low-incidence area accounting for about 47.5% of the total Sicilian resident population (4,968,410 inhabitants), to highlight the characteristics of HCWs infected with SARS-CoV-2 during the period between February 26, 2020 (first laboratory-confirmed case of SARS-CoV-2 infection diagnosed in Sicily among the general population), and May 3, 2020 (the last days of the "lockdown" that began in Italy on March 8, 2020).

Data were obtained from the COVID-19 surveillance systems in place at the local health facilities (LHFs) of four western Sicilian provinces: Agrigento (429,611 inhabitants), Caltanissetta (260,779 inhabitants), Palermo (1,243,328 inhabitants), and Trapani (428,337 inhabitants).

To this end, a dedicated electronic format has been structured and then shared with officials from the prevention departments of recalled LHFs, identified to collect data on HCWs who resulted positive to SARS-CoV-2.

The variables collected were gender, age (mean, standard deviation), period of SARS-CoV-2 infection diagnosis (I subperiod = from February 26, 2020, to March 31, 2020; II subperiod = from April 1, 2020, to May 3, 2020), province (Agrigento, Caltanissetta, Palermo, and Trapani), healthcare context (hospital, local health structure, or primary care service), professional role (physician, nurse, healthcare assistant, laboratory technician), working environment (COVID-19 or not COVID-19 hospital/ward/primary care service).

The diagnosis of SARS-CoV-2 infection, in accordance with WHO guidelines, was considered for nasopharyngeal swab specimens confirmed at real-time polymerase chain reaction (RT-PCR) by one of the diagnostic laboratories authorized by the Sicilian regional health department or by the Italian Ministry of Health (4, 6).

Lastly, data obtained from the LHFs were compared with data on the general population available from the open-access database provided by the Italian national surveillance system for COVID-19 epidemic and with data on HCWs provided by the Italian National Health Institute (6).

The study was approved by the Ethical Committee Palermo 1 of the University Hospital of Palermo (session n. 7 of July 13, 2020).

Statistical Analysis

Quantitative variables were normally distributed and summarized as means with their standard deviations (±SD), while absolute and relative frequencies were calculated for qualitative variables. Chi-square test was performed to compare the distribution of SARS-CoV-2-positive cases. Statistical significance was set with a $p < 0.05$.

All data were entered into an electronic database created by Excel 16.0 software. Descriptive statistics were performed using EpiInfo® ver. 3.5.1 software.

TABLE 1 | Distribution of laboratory-confirmed diagnosis of SARS-CoV-2 infections among HCWs and the general population.

Location	SARS-CoV-2 laboratory-confirmed infection			*p*-value
	Overall	HCWs	General population	
	n (%)			
Western sicily*	944 (100)	85 (9.0)	859 (91.0)	0.18
Remaining part of Italy*	209,773 (100)	21,795 (11.6)	187,978 (88.4)	
Italy overall	210,717 (100)	21,880 (10.4)	188,837 (89.6)	

**Comparison between Western Sicily and Italy (February 26, 2020, to May 3, 2020). HCWs, healthcare workers; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.*

RESULTS

All SARS-CoV-2 infection cases among HCWs in Western Sicily registered by the Sicilian Health Department were contacted and reported in the analysis.

In **Table 1**, the comparison between Western Sicily and Italy of the distribution of SARS-CoV-2 infection cases, confirmed by RT-PCR molecular test, among HCWs and the general population is represented, which occurred during the first wave of the COVID-19 pandemic.

In Western Sicily, during the period in this study, 944 SARS-CoV-2-positive subjects were documented overall. Of these, 85 (9%) were HCWs and the remaining 859 (91%) occurred in the general population.

The total number of SARS-CoV-2-positive subjects reported in the remaining part of Italy in the same period was of 209,773, with 21,795 (11.6%) cases occurring in HCWs and 187,978 (88.4%) documented in the general population.

However, no statistical difference was reported when comparing the distribution of SARS-CoV-2-positive cases between Western Sicily and the remaining part of Italy (*p*-value 0.18).

Table 2 summarizes the characteristics of the 85 HCWs working in the Western Sicily healthcare context with a laboratory-confirmed diagnosis of SARS-CoV-2 infection reported during the first pandemic. Among them, 52 (61.2%) were males and 33 (38.8%) were females, with an average age of 46.4 (SD ± 10.8) years. The majority of HCWs (61; 71.8%) were infected in the first subperiod of the study (from February 26, 2020, to March 31, 2020), while the remaining part (24; 28.2%) during the second subperiod surveyed (from April 1, 2020, to May 3, 2020).

The cases were distributed in the four LHFs as follows: 21 (24.7%) Agrigento, nine (10.6%) Caltanissetta, 35 (41.2%) Palermo, 20 (23.5%) Trapani.

Among the laboratory-confirmed diagnosis of SARS-CoV-2 infection occurring in HCWs from the western Sicilian healthcare context, 43 (50.6%) worked in a hospital and 42 (49.4%) in the primary care services or in other structures belonging to the LHFs.

With regard to the working environment, two (2.4%) HCWs operated in a COVID-19 hospital/ward or primary care service considered at high risk of exposure to SARS-CoV-2, while 83 (97.6%) of the SARS-CoV-2-infected HCWs were from a non-COVID-19 working context.

Lastly, of the 85 SARS-CoV-2-positive HCWs, 22 (26.8%) were physicians, 29 (34.1%) were nurses, five (4.9%) were laboratory technicians, and 29 (34.1%) were healthcare assistants.

TABLE 2 | Characteristics of 85 HCWs with a laboratory-confirmed diagnosis of SARS-CoV-2 infection working in the western Sicilian healthcare context (February 26, 2020, to May 3, 2020).

Characteristics		*n*	(%)
Gender	Male	52	61.2
	Female	33	38.8
Period of diagnosis	I subperiod in study*	61	71.8
	II subperiod in study**	24	28.2
Age	Mean (± SD)	46.4	± 10.8
Province	Agrigento	21	24.7
	Caltanissetta	9	10.6
	Palermo	35	41.2
	Trapani	20	23.5
Healthcare context	Hospital	43	50.6
	Local health structure or primary care service	42	49.4
Professional role	Physician	22	26.8
	Nurse	29	34.1
	Healthcare assistant	29	34.1
	Laboratory technician	5	4.9
Working environment (hospital/ward/primary care service)	COVID-19	2	2.4
	Non-COVID-19	83	97.6

COVID-19, coronavirus disease 2019; HCWs, healthcare workers; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SD, standard deviation.
**From February 26, 2020, to March 31, 2020; **from April 1, 2020, to May 3, 2020.*

DISCUSSION

Since the end of February 2020, when the first evidence of local transmission of SARS-CoV-2 was observed in Italy, many HCWs have also been infected by the pandemic virus (6).

We conducted a cross-sectional study to compare the distribution among the HCWs and the general population of SARS-CoV-2 infection cases occurring in Western Sicily and Italy and to further document the main characteristics of the SARS-CoV-2-infected HCWs operating in the western Sicilian healthcare system, laying in an Italian COVID-19 low-incidence context, during the first wave of the SARS-CoV-2 pandemic. To this end, we accessed data from the COVID-19 surveillance systems in place at the Sicilian LHFs and the open-access database provided by the Italian national surveillance system for COVID-19 epidemic.

During the first wave of the pandemic, the distribution of SARS-CoV-2-positive cases among HCWs and the general population was comparable in Western Sicily and in the whole Italian country.

This finding related to the proportion of SARS-CoV-2-infected HCWs on the overall number of SARS-CoV-2-positive

cases should be further analyzed according to the different incidences of COVID-19 cases decreasing gradient from north to south reported in Italy (6). The greatest burden of the disease documented for northern Italian regions could be attributable to several factors such as the delay in applying the lockdown, the import–export with China, the influenza vaccination coverage rates, the mean seasonal temperatures, and the different impacts of air pollution among different Italian regions, and the role of these factors should be considered when investigating the impact of COVID-19 on HCWs as well (6, 15).

Of interest, the risk of contracting COVID-19 among HCWs is one of the highest because regardless of the specific exposure related to healthcare settings, outside working hours, they are also exposed to the same risk and pathways of contagion reported in the community (16–18).

More in depth, HCWs resulted at very high risk of contracting SARS-CoV-2 infection because of several factors: the healthcare setting (not necessarily an at-risk ward that required tight preventive measures), longer working hours, night shifts that adversely affect the normal waking–sleep rhythm, and poor hand hygiene following contact with patients potentially affected by COVID-19 or the inadequacy of the personal protective equipment (PPE) and of the training in its correct use, provided by the healthcare organization during a pandemic (17, 18).

Our study documented that HCWs at higher risk of SARS-CoV-2 infection during the first pandemic wave were males and had an average age of 46.6 years. These findings are in line with the ones reported in Italy overall during the same time frame (6).

Of relevance, the majority of COVID-19 cases occurring in western Sicilian HCWs were reported during the first month of the first epidemic wave, probably reflecting an improvement over time of the prevention and control measures implemented in the healthcare setting. During the COVID-19 pandemic, HCWs represent the most valuable resource in each country worldwide (19, 20). However, knowledge about the effectiveness of PPE on HCWs caring for patients infected with the novel coronavirus is continuously increasing (21).

Practical Implication

A recent clinical case described the clinical outcome of 41 HCWs who were exposed to aerosol-generating procedures for at least 10 min at a distance of <2 m from a patient with severe pneumonia before the laboratory-confirmed diagnosis of COVID-19 was known (22). Despite the fact that 85% of HCWs were exposed during a procedure involving aerosol generation by the patient while wearing a surgical mask or N95 mask, none of them developed symptoms and all molecular tests resulted negative (22).

These pieces of evidence suggest that surgical masks, hand hygiene, and other standard procedures are effective in protecting HCWs from the SARS-CoV-2 infection. A single case report is not sufficient to determine the best way to protect HCWs from COVID-19, but it is sufficient to suggest that further studies are needed (23).

Moreover, with the present study, we tried to assess the possible increased vulnerability of HCWs to develop the SARS-CoV-2 infection according to their healthcare context and professional role. In particular, the number of HCWs with a confirmed laboratory diagnosis of SARS-CoV-2 working in hospitals was comparable to the one documented for HCWs operating in the primary care services or in other structures belonging to the LHFs, suggesting a similar level of risk for contracting the disease (23, 24). A possible interpretation of these data can be related to a contagion in the LHFs, especially among HCWs working in long-term care facilities for elderly and disabled persons (25).

Therefore, HCWs operating at the territorial services or in a non-COVID-19 setting, on one side, and the ones working at the hospital wards (not dedicated to the treatment of patients affected by COVID-19), could not have greater protection from the virus than their colleagues working in COVID-19 units (26).

In accordance with this hypothesis, 97.6% of the HCWs infected by SARS-CoV-2 in western Sicilian healthcare settings worked in environments irresolute to COVID-19 patterns of care. In this perspective, the experiences conducted in low-resource countries in the management of epidemics within outpatient settings while having a reduced number of available health personnel could be of interest (27–29).

However, one of the most important reasons for early infection among general ward medical staff is the frequent misconduct of admitting patients to the ward without implementing preventive and protective measures (30).

On the contrary, infection rates in the most protected intensive care and emergency wards were lower in unannounced cases of illness (31).

Recent research published in the *Journal of the American Medical Association* found that of the 138 patients studied in a hospital in Wuhan, 29% were HCWs, of whom 31 (77.5%) were working in general wards, seven (17.5%) in emergency rooms, and two (5%) in intensive care units (32).

Of interest, it was assumed that more than 10 HCWs in this ward were infected by a patient with abdominal symptoms and admitted to the surgical ward (32).

One of the reasons for the difficulties in diagnosing COVID-19 and the consequent placement of the patient in wards without adequate measures to contain the virus was found in the atypical presentation symptoms in the initial phase in some patients infected with SARS-CoV-2, such as the gastrointestinal symptoms of the patient under examination, which probably contributed to the rapid spread of the infection among HCWs (32).

Of interest, Traffic Control Bundling (TCB) tool was proven to be effective in drastically reducing infection rates among HCWs in Taiwan during the SARS epidemic (33). Furthermore, the greatest susceptibility to respiratory infectious diseases, such as SARS, was documented for HCWs (24); moreover, data from seven hospitals in China showed an incidence of up to 13.53% of SARS-infected HCWs in intensive care (intensive care units) (26).

More in depth, TCB approach requires the identification of (1) a pre-triage outside hospital (in tents or other shelters), ensuring that patients are triaged in outdoor screening stations so that sick patients are directed to a contamination zone; and (2) risk zones, clearly delimiting separate zones, including a contamination,

transition, and clean zone, each separated by control points. Therefore, it has been suggested to implement the TCB model to face manage the COVID-19 outbreak (33).

HCWs should be adequately trained on TCB protocols including good dressing and undressing practices, proper use of all appropriate personal safety equipment (e.g., respirators and eye protection), and how to move safely between areas (34).

Last but not least, some differences between the working categories were observed in the present study. Nurses and healthcare assistants were the categories most affected by the pandemic virus as compared to physicians probably because their role involves greater physical proximity to the patient (dressing, cleaning, feeding) and, therefore, a greater chance of viral transmission, differently from laboratory technicians who manipulate the swabs in a controlled laboratory (35).

Generally, HCWs could also be easily infected outside work environment in the familiar context. The lack or incorrect use of preventive measures in order to prevent the transmission of SARS-CoV-2 infection is usually more frequent among family members or friends (36).

The strong recommendation of influenza vaccination should be of paramount importance during the 2020/2021 influenza season for certain categories such as HCWs, medical and healthcare residents/students/trainees, police officers, fire workers, and other workers of public utility (37).

In that direction, three Italian regions have tried to introduce local policies or laws that mandate influenza vaccination among HCWs, considering them at high risk for contracting and spreading influenza viruses that could contribute to the burden and overcrowding of health care systems together with SARS-CoV-2 during the next cold season (38, 39).

Could be also useful is the possibility for some HCWs, directly involved in the care of COVID-19-infected patients, to separate temporarily from their families in dedicated COVID-19 hotels for HCWs in order to protect their parents from the risk of secondary infection (40, 41).

Also the mental health and the COVID-19-related mental health effects in the workplace of frontline health and social care professionals should be taken into account in the preventive measures to be considered in the future (42, 43). For instance, HCWs infected by SARS-CoV-2 expected to experience higher levels of stigma among colleagues and in the working setting, reporting increased psychological distress (44–46).

Limitations and Strengths

The main limitation of the present study is linked to its purely descriptive design and to the small number of cases collected that could not be representative of the national context where a different epidemiologic impact was observed, with a COVID-19 incidence decreasing from north to south.

Moreover, further analytical studies, such as ones with a case-control design, should be conducted in the near future to evaluate the different risk factors associated with the infection among HCWs who tested positive for SARS-CoV-2.

Also for future research on SARS-CoV-2 infection of HCWs, an in-depth analysis of psychological variables should be considered.

Finally, the present study contributes to the research conducted on SARS-CoV-2 infections among HCWs in other countries. Specifically, the main elements of originality of the present research can be summarized as follows:

1. HCWs, independently if working in COVID-19 or non-COVID-19 environment, are easily infected in geographical areas with a higher incidence of SARS-CoV-2 infection (Northern vs. Southern Italy during the "first-wave" interesting Italy) (6).
2. There are no significant differences in SARS-CoV-2 infection incidence in accordance to working environment or healthcare context, suggesting a higher risk of transmission among HCWs in non-healthcare settings, where preventive measures are usually neglected.

CONCLUSIONS

In conclusion, it is essential to highlight how the safety of HCWs must be strengthened at a global level through certain essential preventive measures (23).

During the next phases of the COVID-19 pandemic, some preventive measures in order to reduce the SARS-CoV-2 infections among HCWs should be strongly encouraged.

Adequately providing suitable PPE, optimizing human resources in the different healthcare settings, implementing closed and independent groups of HCWs that can be easily isolated, creating traffic control building and dedicated areas for suspected and confirmed cases of SARS-CoV-2 infection, offering influenza vaccination to all HCWs, and providing everything that can guarantee adequate psychophysical support (including refreshments during working shifts, guaranteeing adequate rest, and family support) are among the most important strategies to be considered.

Finally, it should be considered that HCWs are easily infected compared to the general population, but often that infection could occur in hospital and non-hospital settings.

Preventive measures in order to contrast SARS-CoV-2 infection should be continuously applied by the general population until the end of this pandemic, also contributing to a reduction of HCW infections (36).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Committee Palermo 1 of the University Hospital of Palermo (session n.7 of July 13, 2020). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

CC and WM were responsible for the study conception, methodology, and writing the original draft of the manuscript. EC and FV were responsible for reviewing and editing the manuscript and supervision of the project. ACa, VR, GL, and MV were responsible for the statistical analysis. CM and FT were responsible for data curation. LCir, GG, SPa, and SPi were responsible for data collection. DA, ACo, and LCim were responsible for the investigation in the western Sicilian local health facilities. All authors contributed to the article and approved the submitted version.

REFERENCES

1. Hongzhou L, Stratton CW, Tang, YW. Outbreak of pneumonia of unknown etiology in Wuhan, China: the mystery and the miracle. *J Med Virol.* (2020) 92:401–2. doi: 10.1002/jmv.25678
2. Li H, Liu SM, Yu XH, Tang SL, Tang CK. Coronavirus disease 2019 (COVID-19): current status and future perspective. *Int J Antimicrob Agents.* (2020) 55:105951. doi: 10.1016/j.ijantimicag.2020.105951
3. Al-Tawfiq JA. Asymptomatic coronavirus infection: MERS-CoV and SARS-CoV-2 (COVID-19). *Travel Med Infect Dis.* (2020) 35:101608. doi: 10.1016/j.tmaid.2020.101608
4. World Health organization. *WHO Coronavirus Disease (COVID-19) Dashboard.* (2020). Available online at: https://covid19.who.int/?gclid=Cj0KCQiA2uH-BRCCARIsAEeef3m3GsDyJAW0WSvWcOjP_HhPib3C44pLp3TuuNOKDCXwTROr4Zd-AlJ4aAqXhEALw_wcB (accessed December 15, 2020).
5. Costantino C, Cannizzaro E, Alba D, Conforto A, Cimino L, Mazzuco W. Sars-Cov-2 pandemic in the mediterranean area: epidemiology and perspectives. *EuroMediterranean Biomed J.* (2020) 15:102–106. doi: 10.3269/1970-5492.2020.15.25
6. Istituto Superiore di Sanità. *Epicentro Dati Della Sorveglianza Integrata COVID-19 in Italia.* (2020). Available online at: https://www.epicentro.iss.it/coronavirus/sars-cov-2-dashboard (accessed December 15, 2020).
7. Li R, Xuyu C, Ying W, Wenwen W, Ling Z, Xiaodong T. Risk factors of healthcare workers with coronavirus disease 2019: a retrospective cohort study in a designated hospital of Wuhan in China. *Clin Infect Dis.* (2020) 17:2218–21. doi: 10.1093/cid/ciaa287
8. Lai X, Wang M, Qin C, Tan L, Ran L, Chen D, et al. Coronavirus disease 2019 (COVID-2019) infection among health care workers and implications for prevention measures in a tertiary hospital in Wuhan, China. *JAMA Netw Open.* (2020) 3:e209666. doi: 10.1001/jamanetworkopen.2020.9666
9. Sommerstein R, Fux CA, Vuichard-Gysin D, Abbas M, Marschall J, Balmelli C, et al. Risk of SARS-CoV-2 transmission by aerosols, the rational use of masks, and protection of healthcare workers from COVID-19. *Antimicrob Resist Infect Control*. (2020) 9:100. doi: 10.1186/s13756-020-00763-0
10. Torales J, O'Higgins M, Castaldelli-Maia JM, Ventriglio A. The outbreak of COVID-19 coronavirus and its impact on global mental health. *Int J Soc Psychiatry.* (2020) 66:317–20. doi: 10.1177/0020764020915212
11. Cannizzaro E, Ramaci T, Cirrincione L, Plescia F. Work-Related stress, physio-pathological mechanisms, and the influence of environmental genetic factors. *Int J Environ Res Public Health.* (2019) 16:4031. doi: 10.3390/ijerph16204031
12. Lahner E, Dilaghi E, Prestigiacomo C, Alessio G, Marcellini L, Simmaco M, et al. Prevalence of sars-Cov-2 infection in health workers (HWs) and diagnostic test performance: the experience of a teaching hospital in central Italy. *Int J Environ Res Public Health.* (2020) 17:4417. doi: 10.3390/ijerph17124417
13. Ramaci T, Barattucci M, Vella F, Senia P, Cannizzaro E, Scorciapino A, et al. Straining at work and its relationship with personality profiles and individual consequences in healthcare workers (HCWs). *Int J Environ Res Public Health.* (2020) 17:610. doi: 10.3390/ijerph17020610
14. European Union Law. *Commission Directive (EU) 2020/739 of 3 June 2020 Amending Annex III to Directive 2000/54/EC of the European Parliament and of the Council as Regards the Inclusion of SARS-CoV-2 in the List of Biological Agents Known to Infect Humans and Amending Commission Directive (EU) 2019/1833.* (2020). Available online at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020L0739 (accessed December 11, 2020).
15. Amato M, Werba JP, Frigerio B, Coggi D, Sansaro D, Ravani A, et al. Relationship between influenza vaccination coverage rate and COVID-19 outbreak: an Italian ecological study. *Vaccines.* (2020) 8:535. doi: 10.3390/vaccines8030535
16. Costantino C, Fiacchini D. Rationale of the WHO document on risk communication and community engagement (RCCE) readiness and response to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and of the Italian decalogue for prevention departments. *J Prev Med Hyg.* (2020) 61:E1–2. doi: 10.15167/2421-4248/jpmh2020.61.1.1502
17. World Health Organization. *Coronavirus Disease (COVID-19) Outbreak: Rights, Roles and Responsibilities of Health Workers, Including Key Considerations for Occupational Safety and Health.* (2020). Available online at: https://www.who.int/publications-detail/coronavirus-disease-(covid-19)-outbreak-rights-roles-and-responsibilities-of-health-workers-including-key-considerations-for-occupational-safety-and-health (accessed December 11, 2020).
18. Shah ASV, Wood R, Gribben C, Caldwell D, Bishop J, Weir A, et al. Risk of hospital admission with coronavirus disease 2019 in healthcare workers and their households: nationwide linkage cohort study. *BMJ.* (2020) 371:m3582. doi: 10.1136/bmj.m3582
19. The Lancet. COVID-19: protecting health-care workers. *Lancet.* (2020) 395:922. doi: 10.1016/S0140-6736(20)30644-9
20. Cirrincione L, Plescia F, Ledda C, Rapisarda V, Martorana D, Moldovan RE, et al. COVID-19 pandemic: prevention and protection measures to be adopted at the workplace. *Sustainability.* (2020) 12:3603. doi: 10.3390/su12093603
21. Bahl P, Doolan C, de Silva C, Chughtai AA, Bourouiba L, MacIntyre CR, et al. Airborne or droplet precautions for health workers treating COVID-19? *J Infect Dis.* (2020) 16:jiaa189. doi: 10.1093/infdis/jiaa189
22. Ng, K, Poon BH, Kiat Puar TH, Li Shan Quah J, Loh WJ, et al. COVID-19 and the risk to health care workers: a case report. *Ann Intern Med.* (2020) 172:766–67. doi: 10.7326/L20-0175
23. World Health Organization. *Preventing and Managing COVID-19 Across Long-Term Care Services: Policy Brief.* (2020). Available online at: https://www.who.int/publications/i/item/WHO-2019-nCoV-Policy_Brief-Long-term_Care-2020.1 (accessed December 11, 2020).
24. Schwartz J, King CC, Yen MY. Protecting healthcare workers during the coronavirus disease 2019 (COVID-19) outbreak: lessons from taiwan's severe acute respiratory syndrome response. *Clin Infect Dis.* (2020) 28:71:858–60. doi: 10.1093/cid/ciaa255
25. Martin C, Montesinos I, Dauby N, Gilles C, Dahma H, Van Den Wijngaert S, et al. Dynamics of SARS-CoV-2 RT-PCR positivity and seroprevalence among high-risk healthcare workers and hospital staff. *J Hosp Infect.* (2020) 106:102–6. doi: 10.1016/j.jhin.2020.06.028
26. Huh S. How to train health personnel to protect themselves from SARS-CoV-2 (novel coronavirus) infection when caring for a patient or suspected case. *J Educ Eval Health Prof.* (2020) 17:10. doi: 10.3352/jeehp.2020.17.10
27. Quaglio G, Tognon F, Finos L, Bome D, Sesay S, Kebbie A, et al. Impact of Ebola outbreak on reproductive health services in a rural district of sierra leone: a prospective observational study. *BMJ Open.* (2020) 9:e029093. doi: 10.1136/bmjopen-2019-029093
28. Pizzol D, Veronese N, Marotta C, Di Gennaro F, Moiane J, Chhaganlal K, et al. Predictors of therapy failure in newly diagnosed pulmonary tuberculosis cases in Beira, Mozambique. *BMC Res Notes.* (2018) 11:99. doi: 10.1186/s13104-018-3209-9
29. Marotta C, Giaquinto C, Di Gennaro F, Chhaganlal KD, Saracino A, Moiane J, et al. Pathways of care for HIV infected children in Beira, Mozambique: pre-post intervention study to assess impact of task shifting. *BMC Public Health.* (2018) 18:703. doi: 10.1186/s12889-018-5646-8

30. Ong S, Tan Y, Sutjipto S, Chia PY, Young BE, Gum M, et al. Absence of contamination of personal protective equipment (PPE) by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). *Infect Control Hosp Epidemiol.* (2020) 41:614–6. doi: 10.1017/ice.2020.91
31. Hu X, Zhang Z, Li N, Liu D, Zhang L, He W, et al. Self-Reported Use of personal protective equipment among Chinese critical care clinicians during 2009 h1n1 influenza pandemic. *PLoS ONE.* (2012) 7:e44723. doi: 10.1371/journal.pone.0044723
32. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China. *JAMA.* (2020) 323:1061–9. doi: 10.1001/jama.2020.1585
33. Yen MY, Lin YE, Lee CH, Ho MS, Huang FY, Chang SC, et al. Taiwan's traffic control bundle and the elimination of nosocomial severe acute respiratory syndrome among healthcare workers. *J Hosp Infect.* (2011) 77:332–7. doi: 10.1016/j.jhin.2010.12.002
34. Bartoszko JJ, Farooqi MAM, Alhazzani W, Loeb M. Medical masks vs N95 respirators for preventing COVID-19 in healthcare workers: a systematic review and meta-analysis of randomized trials. *Influenza Other Respir. Viruses.* (2020) 14:365–73. doi: 10.1111/irv.12745
35. Tostmann A, Bradley J, Bousema T, Yiek WK. Strong associations and moderate predictive value of early symptoms for SARS-CoV-2 test positivity among healthcare workers, the Netherlands. *Euro Surveill.* (2020) 25:2000508. doi: 10.2807/1560-7917.ES.2020.25.16.2000508
36. Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ. COVID-19 systematic urgent review group effort (SURGE) study authors. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. *Lancet.* (2020) 395:1973–87. doi: 10.1016/j.jvs.2020.07.040
37. Costantino C, Restivo V, Gaglio V, Lanza GLM, Marotta C, Maida CM, et al. Effectiveness of an educational intervention on seasonal influenza vaccination campaign adherence among healthcare workers of the Palermo University Hospital, Italy. *Ann Ig.* (2019) 31:35–44. doi: 10.7416/ai.2019.2256
38. Costantino C, Restivo V, Tramuto F, Casuccio A, Vitale F. Influenza vaccination of healthcare workers in Italy: could mandatory vaccination be a solution to protect patients? *Future Microbiol.* (2020) 14:45–9. doi: 10.2217/fmb-2018-0238
39. Costantino C, Casuccio A, Caracci F, Bono S, Calamusa G, Ventura G, et al. Impact of communicative and informative strategies on influenza vaccination adherence and absenteeism from work of health care professionals working at the University hospital of Palermo, Italy: a quasi-experimental field trial on twelve influenza seasons. *Vaccines.* (2020) 8:E5. doi: 10.3390/vaccines8010005
40. Vimercati L, Tafuri S, Chironna M, Loconsole D, Fucilli FIM, Migliore G, et al. The COVID-19 hotel for healthcare workers: AN Italian best practice. *J Hosp Infect.* (2020) 105:387–8. doi: 10.1016/j.jhin.2020.05.018
41. Vimercati L, Dell'Erba A, Migliore G, De Maria L, Caputi A, Quarato M, et al. Prevention and protection measures of healthcare workers exposed to SARS-CoV-2 in a University hospital in Bari, Apulia, southern Italy. *J Hosp Infect.* (2020) 105:454–8. doi: 10.1016/j.jhin.2020.05.024
42. Pollock A, Campbell P, Cheyne J, Cowie J, Davis B, McCallum J, et al. Interventions to support the resilience and mental health of frontline health and social care professionals during and after a disease outbreak, epidemic or pandemic: a mixed methods systematic review. *Cochrane Database Syst Rev.* (2020) 11:CD013779. doi: 10.1002/14651858.CD013779
43. Giorgi G, Lecca LI, Alessio F, Finstad GL, Bondanini G, Lulli LG, et al. COVID-19-Related mental health effects in the workplace: a narrative review. *Int J Environ Res Public Health.* (2020) 17:7857. doi: 10.3390/ijerph17217857
44. Ramaci T, Barattucci M, Ledda C, Rapisarda V. Social stigma during COVID-19 and its impact on HCWs outcomes. *Sustainability.* (2020) 12:3834. doi: 10.3390/su12093834
45. Barattucci M, Chirico A, Kuvačić G, De Giorgio A. Rethinking the role of affect in risk judgment: what we have learned from COVID-19 during the first week of quarantine in Italy. *Front Psychol.* (2020) 11:554561. doi: 10.3389/fpsyg.2020.554561
46. Cannizzaro E, Cannizzaro C, Martorana D, Moscadini S, Lo Coco D. Effects of shift work on cardiovascular activity, serum cortisol and white blood cells count in a group of Italian fishermen. *EuroMediterranean Biomed J.* (2012) 7:109–13. doi: 10.3269/1970-5492.2012.7.23

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BRIEF RESEARCH REPORT
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Epidemiology Characteristics of COVID-19 Infection Amongst Primary Health Care Workers in Qatar: March-October 2020

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Background: COVID-19 transmission was significant among Healthcare workers worldwide. In March 2020, Qatar started reporting numbers of COVID-19 positive cases among workers in Primary Health Care Corporation (PHCC). The study estimates the burden of the aforementioned infections and examines the demographic characteristics associated with the recorded positivity rates.

Method: A cross-sectional descriptive study was conducted among Primary healthcare workers between March 1st and October 31st, 2020. The study examined the positivity rate of the different types of Primary healthcare workers and, analyzed the demographic characteristics of the infected persons.

Results: 1,048 (87.4%) of the infected Health Care Workers (HCWs) belonged to the age group below 45 years, and 488 (40.7%) HCWs were females. 450 (37.5%) were HCWs clinical staff working in one of the 27 PHCC Health Centers (HCs) Despite the increased patient footfall and risk environment, the COVID dedicated HCs had an attack rate of 10.1%, which is not significantly different from the average attack rate of 8.9% among staff located in other HCs ($p = 0.26$). Storekeepers, engineering & maintenance staff, housekeeping staff, support staff, and security staff (outsourced non-clinical positions) had the highest positivity rates, 100, 67.2, 47.1, 32.4, and 29.5% respectively.

Conclusion: The elevated risk of infection among outsourced non-clinical healthcare workers can be explained by environmental factors such as living conditions. Furthermore, better containment within clinical healthcare workers can be attributed to strict safety training and compliance with preventative measures which is recommended to be implemented across all settings.

Keywords: occupational health, healthcare workers, COVID-19, occupational disease, infectious disease, occupational exposure, primary care

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INTRODUCTION

COVID-19 disease has affected more than 100 million individuals worldwide. Health care workers (HCWs) are at increased risk of contracting infectious diseases because of their occupational exposure (1). In the State of Qatar, more than 150,000 people were infected resulting in ∼200 deaths (2). This has taken many public health

measures such as social distancing strategies to protect its population from COVID-19 disease and to reduce the incidence of new cases, as no specific pharmaceutical intervention was available during the first surge of the pandemic in 2020 (3).

As part of the State of Qatar's efforts to control the COVID-19 pandemic, Primary Healthcare Corporation (PHCC) has had a frontline presence and a proactive role in reducing the spread of coronavirus in Qatar, with dedicated COVID-19 Center, contact tracing, and dedicated drive through swabbing hubs to assist with early detection (4).

The Corporation comprises a network of 27 health centers and employs more than 6,000 employees.

International studies have also estimated that frontline healthcare workers had a higher risk of reporting a positive test than people living in the general community, adjusting for the likelihood of receiving a test (5, 6), and the prevalence of exposed workers in the healthcare industry (7, 8).

While adult patients usually present typical symptoms like fever, cough, taste, and smell disorders, pediatric clinical signs are less severe, making the diagnosis challenging to interpret and increasing the risk of contagion for healthcare workers (9).

A national study in Qatar has identified that COVID-19 infection often occurs with HCWs who are not directly working with COVID-19 patients. One of the reasons depicted is that Personal Protective Equipment (PPE) use is less stringent in such settings (10).

However, there is still limited information available about COVID-19 epidemiological characteristics among HCWs, and it varies in different geographical regions of the world (11, 12). Understanding the epidemiology of COVID-19 infection among healthcare workers at primary care settings is a crucial factor in determining the outbreak trajectories and clinical outcomes at the population level, considering their extent of interaction with the health seeking population in times of a health emergency.

In this study, we aim to estimate the burden of COVID-19 infection amongst all types of workers active at PHCC and identify specific health care workgroups who may be particularly vulnerable to the disease during the ongoing COVID-19 pandemic.

MATERIALS AND METHODS

Method

A cross-sectional descriptive study was conducted to study the burden of COVID-19 among HCWs working at PHCC during the COVID-19 pandemic and analyze the demographic characteristics of the infected HCWs. All HCWs who tested positive for COVID-19 during the period from March 1st to October 31st, 2020, were included for analysis.

Definitions

For this study, a healthcare worker is defined as any person serving in a PHCC healthcare setting, either directly hired or a contractual employee, who had the potential for direct or indirect exposure to patients or their infectious secretions and materials, including, but not limited to, physicians, nurses, paramedics, laboratory workers, and clinical support staff, e.g., wellness gym instructors, administrative staff, facility officers, security officers, or maintenance workers.

Material and Data Source

Secondary data available from PHCC databases were compiled and utilized for this study. Data was extracted from the PHCC staff database, including demographics of the personnel, work location during the pandemic and other related information. Subsequently, this data was mapped to the COVID-19 polymerase chain reaction (PCR) results available on Cerner electronic medical record, the Clinical Information System used by the PHCC.

The compiled data extract was imported into STATA v 15.1—(StataCorp. 2017. College Station, TX: StataCorp LLC.). Chi–square test was used as appropriate; a $p < 0.05$ was considered significant.

The attack rate (AR) was calculated as the percentage of the cumulative number of laboratory confirmed COVID-19 positive HCWs divided by the total number of HCWs. The test positivity rate (PR) was defined as the percentage of the cumulative number of laboratory-confirmed COVID-19 positive HCWs divided by the total number of HCWs tested

RESULTS

During the study period extending from March 1st to October 31st, 2020 PHCC employed 9,172 staff. Among the 7,407 (81%) staff who were subjected to COVID-19 RT-PCR tests, 1,199 (16.2%) were found positive. An overall attack rate of 13.1% was estimated.

The first case among PHCC staff was detected on March 12th, 2020 (week 12). A major peak of cases was observed during April and May (week 18–19), as shown in **Figure 1**.

The median age of the infected HCWs was 36 years. 1,048 (87.4%) belonged to the age group below 45 years and 488 (40.7%) HCWs were females. 695 (58%) were directly hired regular employees of PHCC, while 450 (37.5%) HCWs were clinical staff working in one of the 27 PHCC HCs; amongst them 131 (10.9% of the infected HCWs) worked in the 4 designated COVID-19 health centers.

Significant difference was observed in the positivity rates while comparing the infected HCWs based on various variables. HCWs aged <45 years had a higher attack rate (14.5%) and test positivity (17.5%) compared to their colleagues aged above 45 years ($p < 0.001$). Male employees had a higher attack rate (18.5%) and test positivity (23.8%) compared to female employees ($p < 0.001$). Non-clinical occupations had a higher attack rate (19.7%) and test positivity (26.8%) compared to clinical occupations ($p < 0.001$). Contractual employees had a higher attack rate (42.9%) and test positivity (44.4%) compared to regular PHCC employees ($p < 0.001$).

No significant difference was observed in the infection rates of employees who worked in COVID HCs compared to those working in other PHCC HCs ($p = 0.61$). Detailed comparison of estimated rates is provided in **Table 1**.

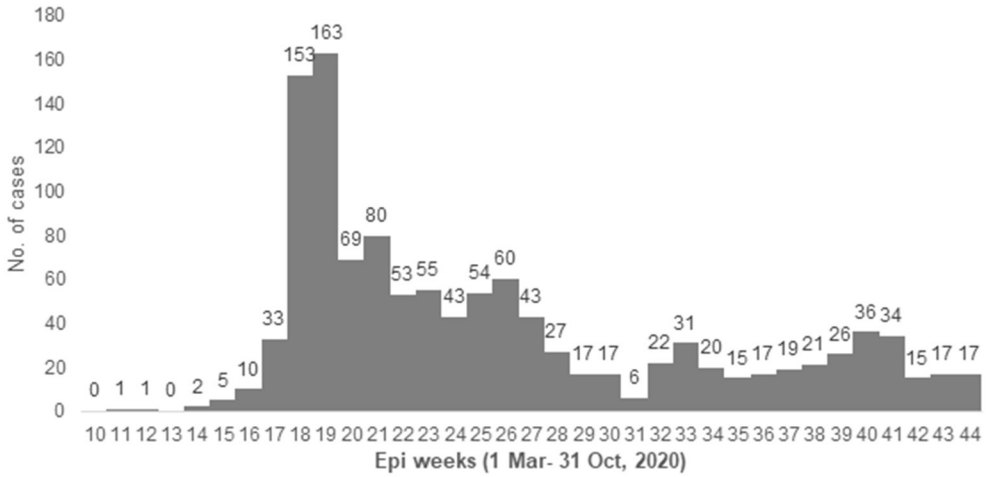

FIGURE 1 | Epidemic curve with case number of HCWs with COVID-19 in PHCC from 1 March to 31 October 2020 (Epiweeks 10–44).

Among the clinical staff, all occupations have been affected by the spread of the COVID-19 with positivity rates ranging between ∼6 and 12%. In particular, pharmacists, dentists, wellness gym staff, and nurses had higher positivity rates compared to the others- 12.7, 11.2, 10.7, and 10.5% respectively (**Table 2**).

Amongst the non-clinical occupations, storekeepers, engineering & maintenance staff, housekeeping staff, support staff, and security staff had the highest positivity rates, 100, 67.2, 47.1, 32.4, and 29.5% respectively (**Table 3**). Administrative Staff who are predominant amongst non-clinical staff had a positivity rate of 3.5% and an attack rate of 1.8%.

Out of the 27 PHCC HCs, four HCs had been designated official assessment and triage COVID-19 HCs starting March 15, 2020 (**Table 4**). Similar patient volumes were seen at both these categories of HCs- 143,154 suspected patients were swabbed at the 4 COVID HCs and a cumulative number of 145,565 suspected patients were swabbed in all other HCs.

Despite the increased patient footfall and risk environment, the COVID HCs had an attack rate of 10.1%, which is not significantly different from the average attack rate of 8.9% among staff located in other HCs ($p = 0.26$).

DISCUSSION

PHCC has taken precautionary measures to prevent the spread of COVID-19 amongst its HCWs. They have maintained vital services such as well-baby and vaccinations, ultrasound, and premarital testing clinics, all by encouraging patients to visit health centers only if medical consultation is imperative. Online health services, through virtual consultations, were provided by PHCC to minimize the risk of exposure and contamination for both patients and medical staff (13).

Designated assessment and triage COVID-19 centers, although having swabbed almost six times more suspected patients per HC than other PHCC HCs, have seen almost similar attack rates amongst their staff when comparing to other PHCC HCs. The similarities in the frequency of infected staff, despite the vast difference in the levels of exposure, can be attributed to continuous training and raising awareness amongst staff on the proper use of PPE and the implementation of stringent infection prevention and control policies and procedures which helps prevent the spread of COVID-19 virus (14).

PHCC has provided adequate education and training content, which includes the use of PPE, hand hygiene, medical waste management, sterilization of patient-care devices, and management of occupational exposure. Within these health centers, non-clinical staff who are predominantly outsourced employees seem to have a higher test positivity and attack rates than the clinical staff.

The higher positivity and attack rates amongst non-clinical staff could be due to several educational, social, and environmental factors such as lack of awareness and training on how to use PPE, less enforcement of occupational safety measures, and crowded accommodations, which is considered to be one of the strong forecasters and substantial contributing risk factors for health problems amongst workers (15). Craft and Manual Workers are more likely to live in crowded shared accommodation in constant proximity to one another, increasing the likelihood of COVID-19 spread through community transmission. They also often gather for social and recreational activities, shared dining, and use of shared equipment (16). The lower positivity among clinical staff can be attributed to the stringent enforcement of infection prevention and control measures, despite the front line aspect of their daily work routine (17). The high volume of patients, combined with an increased need for intensive care, forced HCWs to reorganize care delivery models, in order to minimize risk especially those involving otolaryngologic invasive procedures (18, 19).

Some of these measures include continuously wearing masks, frequent handwashing, and constant availability of sanitizers, in addition to the implementation of social distancing

TABLE 1 | PHCC Staff Characteristics, screening proportion, attack rate and positivity rate (1 March–31 October).

Variable	Total staff	Tested	Positives	Attack rate	Test positivity	*p-value*
All staff	9,172	7,407	1,199	13.1%	16.2%	
Age group						*<0.001*
<45 years	7,250	5,999	1,048 (87.4%)	14.5%	17.5%	
45 years and above	1,922	1,408	151 (12.6%)	7.9%	10.7%	
Gender						*<0.001*
Female	5,320	4,415	488 (40.7%)	9.2%	11.1%	
Male	3,852	2,992	711 (59.3%)	18.5%	23.8%	
Occupation						*<0.001*
Clinical	5,363	4,610	450 (37.5%)	8.4%	9.8%	
Non-clinical	3,809	2,797	749 (62.5%)	19.7%	26.8%	
Type of employment						*<0.001*
Direct hire	7,996	6,271	695 (58%)	8.7%	11.1%	
Contractual	1,176	1,136	504 (42%)	42.9%	44.4%	
Location of work						*0.61*
Covid-19 HC	1,301	1,150	131 (10.9%)	10.1%	11.4%	
Other HC	6,001	4,893	532 (44.4%)	8.9%	10.9%	

The italic value is the significance as explained in the methodology a $p < 0.05$ was considered significant.

TABLE 2 | Attack rate and test positivity among clinical staff.

Occupation	Total staff	Total tested	Positives	Attack rate (%)	Test positivity (%)
Nurse	2,506	2,255	236	9.4	10.5
Physician	1,079	858	72	6.7	8.4
Pharmacist	479	403	51	10.6	12.7
Lab technician	413	350	28	6.8	8.0
Dentist	242	196	22	9.1	11.2
Dental staff	231	192	14	6.1	7.3
Radiology staff	211	189	12	5.7	6.3
Wellness gym staff	94	75	8	8.5	10.7
Physiotherapist	54	47	3	5.6	6.4
Allied health staff	48	41	4	8.3	9.8

TABLE 3 | Attack rate and test positivity among non-clinical staff.

	Total staff	Total tested	Positives	Attack rate (%)	Test positivity (%)
Administrative staff	1,326	689	24	1.8	3.5
Receptionists and cashiers	807	657	112	13.9	17.0
Housekeeping staff	530	526	248	46.8	47.1
Support staff	390	358	116	29.7	32.4
Security officers	388	322	95	24.5	29.5
Transport staff	135	82	18	13.3	22.0
Customer service staff	106	81	10	9.4	12.3
Engineering & maintenance staff	112	67	45	40.2	67.2
Storekeepers	15	15	15	100	100

strategies. The administrative staff are considered outliers to the non-clinical staff with low attack rate because they undergo similar safety training as clinical staff and are more likely to live in separate accommodation. Among the clinical workers, pharmacists, dentists, nurses, and wellness staff encountered slightly higher positivity rates, which can be attributed to their nature of work as dedicated COVID-19 swabbing staff. Additionally, pharmacists have frequent dealings with storekeepers and postal department drivers to distribute medication for home delivery. The dental team faces a higher risk of infection due to the oral nature of their work. Nurses and wellness staff have daily close encounters with patients and staff alike, being the first line of contact in the triage selection process.

Although female staff at PHCC outnumber their male counterparts, the spread of the COVID-19 virus has been more pronounced amongst males with higher positivity and attack rates. Some occupations such as storekeeper, security, and engineering & maintenance, predominantly occupied by male staff, have seen considerably high rates of infection. Furthermore, male craft and manual workers, as previously mentioned, are more likely to contract the COVID-19 virus due to the nature of their accommodation and their socio-recreational activities. Various studies have also examined the gender dimension of COVID-19 infection and the epidemiological findings reports have found that male individuals represent in general a higher proportion of the infected COVID-19 patients due to biological, social and economic factors between the genders (20).

According to the analyzed data, staff below 45 years of age have seen higher positivity and attack rates. This could mainly be attributed to the fact that most of the non-clinical outsourced staff are below 45 years of age. Additionally, some of the workers above 55 years of age were allowed to work from home and minimize their daily exposure to the virus through a range of teleconsultation services (21).

In evaluating the transmission of COVID-19 among hospital staff, it is crucial to test both clinical and non-clinical staff

TABLE 4 | Attack rate among staff in various health centers.

PHCC facility	Total staff	Positive	Attack rate (%)
Specialized COVID health centers	**1,301**	**131**	**10.1**
Gharrafat Al Rayyan	290	30	10.3
Muaither	327	36	11.0
Rawdat Al Khail	389	36	9.3
Umm Slal	295	29	9.8
Other PHCC health centers	**6,001**	**532**	**8.9**
Abu Bakr Al-Siddiq	318	26	8.2
Abu Nakhla	208	25	12.0
Airport	241	37	15.4
Al Daayen	148	13	8.8
Al Jumailiya	30	3	10.0
Al Kaaban	52	4	7.7
Al Karaana	67	4	6.0
Al Khor	156	17	10.9
Al Rayyan	272	23	8.5
Al Ruwais	135	4	3.0
Al Sheehaniya	193	11	5.7
Al Thumama	249	22	8.8
Al Waab	209	20	9.6
Al Wajbah	287	28	9.8
Al Wakra	291	11	3.8
Staff Clinic	1,275	102	8.0
Leabaib	349	23	6.6
Leghwairiya	40	7	17.5
Madinat Khalifa	262	22	8.4
Mesaimeer	321	39	12.1
Omar Bin Al Khatab	249	23	9.2
Qatar University	223	22	9.9
Umm Ghuwailina	170	21	12.4
West Bay	256	25	9.8

during the pandemic to frame the extent of viral spread. Even with limited infection control measures in non-clinical areas, COVID-19 virus transmission did not occur among hospital staff beyond community outbreak, reflecting the effectiveness of infection control measures and appropriate usage of personal protective equipment (22, 23). This also highlights the need to implement the same stringent control measures on non-clinical staff as well, namely outsourced workers, who should undergo training on how to avoid the spread of the virus by taking proper precautionary measures and making appropriate use of their protective equipment. Improvements in their living conditions will ultimately reduce the risk of infection by promoting social distancing and minimizing community transmissions.

These findings highlight the importance of developing a clear and concise national occupational health policy underscoring the importance of training and infection control measures and outlining minimum requirements of health promotion and living environment of staff working in a healthcare setting.

RESOURCE IDENTIFICATION INITIATIVE

(Cerner Millennium, RRID:SCR_013581)

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

MA-K conceived the study and oversaw overall direction and planning. JA and MK extracted and analyzed the data. MA-K, MA, and AA-N analyzed and interpreted the data. MA-K, SS, and HA-R suggested the different points for the discussion section. MA-K, AA-N, JA, and SS were major contributors in writing the manuscript. All authors discussed the results and contributed to the final manuscript.

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REFERENCES

1. Jones N, Carver C. Are interventions such as social distancing effective at reducing the risk of asymptomatic healthcare workers transmitting COVID-19 infection to other household members. *CEBM Oxford COVID-19 Evidence Service*. Available online at: https://www.cebm.net/oxford-covid-19/
2. Ministry of Public Health, Qatar (MOPH). (2020). *COVID-19 Home*. Retrieved from: https://covid19.moph.gov.qa/EN/Pages/default.aspx
3. Ministry of Public Health, Qatar (MOPH). (2020). *COVID-19 Home*. Retrieved from: https://covid19.moph.gov.qa/EN/Pages/default.aspx
4. Primary Healthcare Corporation, Qatar (PHCC). (2020). *Drive-Thru*. Retrieved from: https://www.phcc.qa/portal_new/index/index.php?limit=home
5. Dong XC, Li JM, Bai JY, Liu ZQ, Zhou PH, Gao L, et al. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. *Zhonghua liu xing bing xue za*. (2020) 41:145–51. doi: 10.3760/cma.j.issn.0254-6450.2020.02.003
6. Nguyen LH, Drew DA, Joshi AD, Guo C-G, Ma W, Mehta RS, et al. Risk of COVID-19 among frontline healthcare workers and the general community: a prospective cohort study. *medRxiv [Preprint]*. doi: 10.1101/2020.04.29.20084111
7. Ran L, Chen X, Wang Y, Wu W, Zhang L, Tan X. Risk factors of healthcare workers with corona virus disease 2019: a retrospective cohort study in a designated hospital of Wuhan in China. *Clin Infect Dis*. (2020) 71:2218–21. doi: 10.1093/cid/ciaa287
8. Istituto Superiore di Sanità. Integrated surveillance of COVID-19 in Italy. (2020). Available online at: https://www.epicentro.iss.it/en/coronavirus/bollettino/Infografica_10aprile%20ENG.pdf. Published (accessed July 29, 2020).
9. Maniaci A, Iannella G, Vicini C, Pavone P, Nunnari G, Falsaperla R, et al. A case of COVID-19 with late-onset rash and transient loss of taste and smell in a 15-year-old boy. *Am J Case Rep*. (2020) 21:e925813. doi: 10.12659/AJCR.925813

10. Alajmi J, Jeremijenko AM, Abraham JC, et al. COVID-19 infection among healthcare workers in a national healthcare system: the Qatar experience. *Int J Infect Dis.* (2020) 100:386–9. doi: 10.1016/j.ijid.2020.09.027
11. Epidemiology of and Risk Factors for Coronavirus Infection in Health Care Workers: A Living Rapid Review. *Ann Intern Med.* (2020) 173:120–36. doi: 10.7326/M20-1632
12. Chou R, Dana T, Buckley DI, Selph S, Fu R, Totten AM. Epidemiology of and risk factors for coronavirus infection in health care workers. *Ann Internal Med.* (2020) 173:120–36. doi: 10.7326/L21-0143
13. Ministry of Public Health, Qatar (MOPH). (2020). *COVID-19 Home*. Retrieved from: https://www.moph.gov.qa/english/mediacenter/News/Pages/NewsDetails.aspx?ItemId=133
14. Huang L, Lin G, Tang L, Yu L, Zhou Z. Special attention to nurses' protection during the COVID-19 epidemic. *Crit Care.* (2020) 24:120. doi: 10.1186/s13054-020-2841-7
15. Alahmad B, Kurdi H, Colonna K, Gasana J, Agnew J, Fox MA. COVID-19 stressors on migrant workers in Kuwait: cumulative risk considerations. *BMJ Glob Health.* (2020) 5:e002995. doi: 10.1136/bmjgh-2020-002995
16. Bener A. Health status and working condition of migrant workers: major public health problems. *Int J Prev Med.* (2017) 8:68. doi: 10.4103/ijpvm.IJPVM_396_16
17. Hunter E, Price DA, Murphy E, van der Loeff IS, Baker KF, Lendrem D, et al. First experience of COVID-19 screening of health-care workers in England. *Lancet.* (2020) 395:e77–8. doi: 10.1016/S0140-6736(20)30970-3
18. Gelardi M, Iannuzzi L, Trecca EMC, Kim B, Quaranta NAA, Cassano M. COVID-19: what happened to all of the otolaryngology emergencies? *Eur Arch Otorhinolaryngol.* (2020) 277:3231–2. doi: 10.1007/s00405-020-06046-z
19. Spinato G, Gaudioso P, Boscolo Rizzo P, et al. Risk management during COVID-19: safety procedures for otolaryngologists. *Acta Biomed.* (2021) 92:e2021105. doi: 10.23750/abm.v92i1.11281
20. Kopel J, Perisetti A, Roghani A, Aziz M, Gajendran M, Goyal H. Racial and gender-based differences in COVID-19. *Front Public Health.* (2020) 8:418. doi: 10.3389/fpubh.2020.00418
21. Iyengar K, Mabrouk A, Jain VK, Venkatesan A, Vaishya R. Learning opportunities from COVID-19 and future effects on health care system. *Diabetes Metab Syndr.* (2020) 14:943–46. doi: 10.1016/j.dsx.2020.06.036
22. Zheng C, Hafezi-Bakhtiari N, Cooper V, Davidson H, Habibi M, Riley P, et al. Characteristics and transmission dynamics of COVID-19 in healthcare workers at a London teaching hospital. *J Hosp Infect.* (2020) 106:325–9. doi: 10.1016/j.jhin.2020.07.025
23. Stock AD, Bader ER, Cezayirli P, Inocencio J, Chalmers SA, Yassari R, et al. COVID-19 infection among healthcare workers: serological findings supporting routine testing. *Front Med.* (2020) 7:471. doi: 10.3389/fmed.2020.00471

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BRIEF RESEARCH REPORT
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Investigation on the Loss of Taste and Smell and Consequent Psychological Effects: A Cross-Sectional Study on Healthcare Workers Who Contracted the COVID-19 Infection

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The aim of this study was to investigate the correlation between psychological distress and taste and sense of smell dysfunctions on healthcare workers (HCW) who contracted the COVID-19 infection in the midst of the disease outbreak. Reports of sudden loss of taste and smell which persist even after recovery from COVID-19 infection are increasingly recognized as critical symptoms for COVID-19 infections. Therefore, we conducted a cross-sectional study on COVID-19 HCW ($N = 104$) who adhered to respond to a phone semistructured interview addressing the virus symptoms and associated psychological distress. Data were collected from June to September 2020. Findings confirm the association between experienced taste/olfactory loss and emotional distress and suggest that dysfunctions of taste and smell correlate positively with anxiety and depression. Furthermore, their psychological impact tends to persist even after the recovery from the disease, suggesting the need for appropriate psychological interventions to prevent people from developing more serious or long-lasting psychological disorders and, as far as HCW, to reduce the risk of work-related distress.

Keywords: COVID-19, taste disorder, smell loss, psychological distress, healthcare workers

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INTRODUCTION

In December 2019, an outbreak of pneumonia with unknown origin began in China's Hubei Province raising global health concerns due to the ease of transmission. After numerous studies conducted around the world, a novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified and was called "coronavirus-19" (COVID-19). For the National Institutes of Health (1), several symptoms characterized this infection, ranging from asymptomatic/mild symptoms to severe illness and death. In particular, COVID-19 symptomatology included cough, fever, and shortness of breath, as well as weakness, malaise, respiratory distress, muscle pain, sore throat, loss of taste, and/or smell (2–8).

In countless studies (9–14), smell dysfunction has been demonstrated as one of the first among other neurologic manifestations of both hospitalized and mild COVID-19 patients (15).

World's pandemics are usually associated with adverse mental health consequences as reported in different studies (16–22). According to Rajkumar (23), first evidence suggests that symptoms of anxiety and depression and self-reported distress are common psychological reactions to the COVID-19 pandemic and may be associated with disturbed sleep.

However, studies on determinants of psychological distress have rarely focused on the clinical manifestation of the SARS-COV-2.

During the first wave of COVID-19 pandemic, a psychology crisis unit (coworked with the Occupational Medicine Service) kept in touch by phone calls with HCW infected with COVID-19 to prevent psychological distress, and observed an association between psychological distress and olfactory/taste dysfunctions.

Therefore, our primary aim was to determine the psychological impact of COVID-19 symptomatology and, more specifically, whether taste/olfactory dysfunctions were associated with more emotional disorders as compared with subjects not experiencing these sense symptomatologies. Indeed, it is well-known that taste and olfactory sensory dysfunctions/loss represent an early manifestation of infection (7, 10, 11, 24) that can have a negative impact on emotional well-being and quality of life (25) people with anosmia often refer feelings of loneliness, fear, and depression as well-difficulties concerning social and sexual relationship, concerns about personal hygiene. Taste disturbance or loss can also cause subjective discomfort and have a negative impact on nutrition, indeed depression subsequent to gustatory dysfunction has been described (26). In addition, in one study, Weiffenabch and Bartoshuk (27) reported how dysfunction of taste and smell can amplify psychological distress. Further analyses concerned the prevalence of smell and taste dysfunctions, how these symptoms were distributed within our sample, and at what stage of the disease they tended to emerge. Because the mental status of health professionals directly affected by the COVID-19 epidemic to our knowledge has been under-addressed, we focus on a sample of HCW who contracted the infection during the first wave of COVID-19. The purpose of the study will also investigate the distress and psychological needs and serve to better target and plan support services for healthcare professionals working in COVID-19 centers, especially focusing on work-related distress. The HCW normally represent an important sector, actually overexposed to COVID-19 consequences, that needs to be further explored and protected. This study represents a started point for future researches.

MATERIALS AND METHODS

A no-profit study representing a cross-sectional investigation was conducted from June to September 2020 according to the local Ethical Committee (N.051/2020). HCW of the Trieste area in Northern Italy who contracted the COVID-19 infection in the midst of the disease outbreak were interviewed by phone by psychologists of the same healthcare service. The presence of infection was determined by the positive result of molecular swabs as established by the World Health Organization (28).

Participants

One hundred twenty-three HCW were involved in the study by occupational doctors from an Italian local network of hospitals. However, the final sample of subjects who adhered to participate to the study was composed by a total of 104 subjects (women $N = 71$ and men $N = 33$) between the ages of 23 and 65 years (mean $= 43$) who completed the interview and the questionnaires. At the time of the interview, participants were COVID-19 positive, COVID-19 negative with symptoms, and COVID-19 negative without symptoms (see **Table 1**). The inclusion criteria were age >18–<70; contraction of COVID-19 infection; good understanding of the Italian language; and those who have expressed their favorable consent to participate in the study. The exclusion criterion was inability to cooperate due to high distress at the time of the interview evaluated by the psychologist.

Instruments and Procedure

Subjects were reached by phone and administered a semistructured interview which involved questions concerning clinical symptoms of COVID-19 including taste and smell problems, the distress thermometer (29), and the Hospital Anxiety and Depression Scale (HADS) (30, 31). The distress thermometer (DT) is a simple self-reported tool that screens for symptoms of distress and has been found valid in measuring psychological distress in different countries, cultures, and pathological populations as confirmed by different studies (32–34). It measures the stress variable on a 0- (no distress) to 10-rating (extreme distress) scale. The DT can be considered a continuous variable, with an established cutoff of 5 indicating experience of significant distress and need for attention or can be employed to classify people with low (0–3), moderate (4–5), and high levels (>6) of stress, as reported by Grassi et al. (35).

The HADS questionnaire is a 14-item scale designed to detect emotional disturbances in non-psychiatric patients (31) in hospital settings by screening for the two most frequent disorders: anxiety and depression. Each item is rated on a 4-point scale, ranging from 0 to 3, with 3 indicating higher symptom frequency. Two separate subscales identifying anxiety and depression symptoms can be obtained as well as a total score of psychological state. Total scores for each subscale range from

TABLE 1 | Participants demographics and clinical characteristics.

	Total cohort ($n = 104$)			
Demographics				
Gender				
Male	33 (31.7%)			
Female	71 (68.3%)			
Age (years)				
Mean (SD)	42 (11)			
Median (min-max)	44 (23–65)			
Patient's status at interview				
COVID-19 positive	5 (4.8%)			
COVID-19 negative with symptoms	38 (36.5%)			
COVID-19 negative without symptoms	61 (58.7%)			
	All cohort ($n = 104$)	**Female ($n = 71$)**	**Male ($n = 33$)**	***P*-value**
COVID-19 symptoms				
Fatigue	85 (83.3%)	60 (85.7%)	25 (78.1%)	0.34
Olfactory dysfunctions	84 (81.6%)	62 (88.6%)	22 (66.7%)	0.007
Taste dysfunctions	79 (76.7%)	59 (84.3%)	20 (60.6%)	0.008
General Illness	76 (73.8%)	53 (75.7%)	23 (69.7%)	0.52
Muscle aches	66 (64.1%)	43 (61.4%)	23 (69.7%)	0.41
Nasal Congestion	64 (62.1%)	47 (67.1%)	17 (51.5%)	0.13
Fever	62 (60.2%)	42 (60.0%)	20 (60.6%)	0.95
Headache	52 (50.5%)	37 (52.9%)	15 (45.5%)	0.48
Dry cough	48 (46.6%)	33 (47.1%)	15 (45.5%)	0.87
Sore throat	36 (35.0%)	29 (41.4%)	7 (21.2%)	0.05
Diarrhea	28 (27.2%)	19 (27.1%)	9 (27.3%)	0.99
Fainting	16 (15.5%)	11 (15.7%)	5 (15.2%)	0.94
Numbness	10 (9.7%)	6 (8.6%)	4 (12.2%)	0.57
Difficulty closing eyes	2 (1.9%)	1 (1.4%)	1 (1.3%)	0.54

0 to 21, categorized as: normal (0–7), borderline (8–10), and present disorder ($\geq$11).

In the present study, the DT was proposed to participants considering two different periods of time: (1) COVID-DT which refers to the stress perceived during the early illness and (2) Current-DT which indicates the level of stress perceived at the time of the interview about COVID-19. The HADS score refers only to the time of the interview.

Data Analysis

Taking into account the primary objective of the study, namely the association between olfactory and gustatory dysfunctions and a state of distress, the sample size available ($n = 104$) can be considered sufficient to determine a difference of 0.62 (medium Cohen's d effect size) in the outcome evaluation scale (DT) assuming a power of 80% (1-β) and a level of significance of 5% (α) (two-tailed student t test).

Categorical variables were expressed by frequencies and percentage, while continuous variables were expressed by mean [standard deviation (SD)] or median [range (min-max)], as appropriate according to data distribution verified through Shapiro Wilk normality test. Student's t test or Mann-Whitney test were used to compare continuous variables (age, DT, HADS scores) with respect to groups of interests. Independent Chi-square test or Fischer exact test (when appropriate) were performed to evaluate and investigate associations among categorical variables. Paired Wilcoxon test compared DT values perceived by the patients during COVID-19 infection with current distress. Spearman linear correlation coefficients were calculated in order to verify correlation among different psychological scores. Multivariate linear regression models were performed to identify risk factors for psychological disorders and results reported as Beta coefficient regression with 95% confidence interval. All the statistical tests were two sided, and statistical significance was defined as p-value < 0.05. Analyses were performed using statistical software R, v. 4.0.3, 2020.

RESULTS

COVID-19 Symptoms

Subjects' response analysis on COVID-19 symptoms revealed that only one person was asymptomatic and three workers required hospitalization, while the majority of the sample experienced mild to moderate symptomatology with an

TABLE 2 | Analysis of the characteristics of smell and taste dysfunctions: temporal onset, type of dysfunctions, and resolution.

	Smell dysfunction ($n = 84$)	Taste dysfunction ($n = 79$)	*P*-value
Temporal onset			
Before other COVID-19 symptoms	11 (13.4%)	10 (13.2%)	0.64
Together with other COVID-19 symptoms	20 (24.4%)	14 (18.4%)	
After the emergence of COVID-19	51 (62.2%)	52 (68.4%)	
Not available	2 (2.4%)	3 (3.8%)	
Type of dysfunction			
Sensory alteration	6 (7.2%)	17 (21.5%)	0.004
Loss	66 (79.5%)	40 (50.6%)	
Reduction	11 (13.3%)	22 (27.8%)	
Not available	1 (1.2%)	0	
Resolution at the time of interview			
Yes completely	44 (52.4%)	52 (66.7%)	0.18
Yes partially	34 (40.5%)	22 (28.2%)	
No	6 (7.1%)	4 (5.1%)	
Not available	0	1 (1.3%)	

average of 7 symptoms (60.2%). The most frequent symptoms were fatigue (83%), olfactory dysfunctions (82%), and taste dysfunctions (77%) Women reported dysfunctions significantly greater than men in smell (89 vs. 67%, $p = 0.007$), taste (84 vs. 61%, $p = 0.008$), and sore throat (41 vs. 21%, $p = 0.05$) (see **Table 1**). The only correlation between age and type of symptom was found for numbness: the presence of the symptom is associated with a greater age (medians 50 vs. 43, $p = 0.03$).

Smell and Taste Dysfunctions

The characteristics of taste and smell dysfunctions have been analyzed more in depth (see **Table 2**): temporal onset in most of the sample is, on average, 6 days after the beginning of other symptoms (smell in 62% of the group and taste in 68%); only for a few of them these disorders emerged before other symptoms (in 13% of subjects, both dysfunctions appeared on an average of 5 days before other complaints). The type of dysfunction has also been explored, considering both sensory alteration, loss, or reduction. Anosmia and ageusia are the most frequent reported dysfunction particularly in case of smell (nearly 80% olfaction vs. 51% of taste, $p = 0.004$). No significant differences have been found in the rate of taste/smell resolution at the time of the interview ($p = 0.18$), though it resulted higher in case of taste problems (67% of taste vs. 52% of smell) and persistence of sensory disorders was similar for both senses (taste 5% and smell 7%).

At the time of the interview, the most frequent symptoms in the "COVID-19 negative with symptoms" group ($n = 38$), remained "smell dysfunction" ($n = 21$, 55%), and "taste dysfunction" ($n = 12$, 32%).

TABLE 3 | Distress thermometer scores at the time of COVID illness.

Total cohort ($n = 104$)			
DT scores			
<5	24 (23.3%)		
≥5	79 (76.7%)		
Not available	2 (1.9%)		
Median DT score (min-max)	7 (0–10)		
	DT score <5 ($n = 25$)	**DT score ≥5 ($n = 79$)**	***P*-value**
Demographics			
Gender			
Male	8 (76.1%)	25 (75.8%)	0.97
Female	17(23.9%)	54 (24.2%)	
Age			
Median (min-max)	44 (24–61)	43 (23–65)	
Emotional states			0.86
Anxiety	5 (20.0%)	62 (78.5%)	<0.001
Nervousness	13 (52.0%)	61 (77.2%)	0.02
Irritability	6 (24.0%)	38 (48.1%)	0.03
Fear	7 (28.0%)	53 (68.0%)	<0.001
Sleep disorders	7 (28.0%)	43 (54.5%)	0.02
Negative mood	5 (20.0%)	52 (65.8%)	<0.001
Relationship	1 (4.0%)	20 (25.3%)	0.02
Pain	7 (28.0%)	38 (48.7%)	0.07
Nausea/constipation/diarrhea	5 (20.0%)	28 (35.4%)	0.15
Olfactory dysfunctions	13 (52.0%)	54 (68.4%)	0.14
Taste dysfunctions	10 (40.0%)	54 (68.4%)	0.01
Concentration	6 (24.0%)	39 (49.4%)	0.03
Loneliness	2 (8.0%)	41 (51.9%)	<0.001
COVID-19 symptoms			
Fatigue	16 (66.7%)	69 (84.5%)	0.01
Diarrhea	3 (12.5%)	25 (31.7%)	0.05
Loss of taste	14 (58.3%)	65 (82.3%)	0.02
Number of COVID symptoms ≥7	10 (41.7%)	52 (65.8%)	0.03

DT at the Period of COVID-19 Positivity (COVID-DT)

As far as the emotional state reported by subjects, the DT showed a median score of 7 out of 10 when referring to the period of the COVID-19 illness. Gender and age were not associated with DT at the period of COVID-19 positivity (COVID-DT). Eighty-six percent of the sample declared moderate to high distress, and the most frequent manifestations of psychological symptoms were anxiety, irritability, negative mood, and a sense of loneliness (see **Table 3**). In addition, COVID-DT correlates significantly with the presence of some COVID-19 symptoms (fatigue, diarrhea, taste loss) and patients with more than seven symptoms (median value of symptom prevalence) showed higher levels of distress (see **Table 3**). While the loss of smell does not appear to be related to greater distress, in patients who have lost the taste, the level of

distress is significantly higher in the period of illness. This result remained confirmed in the multivariate analysis (Beta = 1.58, 95% CI:0.15; 3.00, $p = 0.02$, see **Supplementary Table 1**).

HADS at the Time of Interview

Subjects' psychological state has been specifically investigated also through the HADS. Answers to the HADS questionnaire revealed the presence of anxiety and depression in a small percentage of cases at the time of the interview (score ≥11 <13% for anxiety and 6% for depression). Age and gender were not associate with HADS scores.

Looking at the relationship between the scores on the HADS scale and the loss of taste/smell, anxiety results to be significantly higher in patients with alterations in both senses than in subjects without these disorders. On the other hand, subjects who report loss of taste constantly refer also symptoms of depression, while in case of smell loss there is only a tendency, though not significant, to report more depressive symptoms (see **Tables 4a**,**b**,**c**). However, in multivariate analysis, the only factor associated at the limit of significance, with anxiety/depression disorders was sex: men tend to suffer less from these disorders than women (see **Supplementary Tables 2**, **3**).

Correlation Among Psychological Distress Scales

To complete the analyses of subjects' psychological state, results from the two administration of the DT (i.e., COVID-TD and Current-DT) have been compared, as well as the HADS total score with the Current-DT. As shown in **Table 5**, all psychological distress scales were correlated. In particular, at the Current-DT, subjects gained scores significantly lower than those obtained in the COVID period (median DT 4 and 7, respectively, $p < 0.001$) even though 53 subjects (51%) reached scores of clinical interest (DT ≥4: moderate and high distress). A strong association has also been found between the CurrentpDT and the HADS questionnaire: 86% of subjects who reached a high HADS total score (HADS >13) have also gained a critical Current-DT score (DT >5), while only 29% of subjects with lower HADS scores (HADS <13) have an high DT score ($p < 0.001$) (see **Supplementary Table 4**). Accordingly, results from the administration of HADS confirm that 30 out of the all cohort (29%) would require clinical psychological intervention as shown by their overall HADS score (≥13).

DISCUSSION

This study evidences that smell and taste dysfunctions in subjects with mild to moderate COVID-19 symptoms are associated with higher levels of psychological distress compared to those not experiencing taste and smell dysfunctions [as observed by (25, 36)]. Anxiety and depressive symptoms are the most frequent responses, even though depression appears to be higher in relation to ageusia with respect to anosmia. Indeed, it is well-known that olfactory and taste sensory loss can have a negative impact on emotional well-being and quality of life, leading to feelings of loneliness, fear, and depression, as well as difficulties concerning social/sexual relationships (25, 36). Since taste and smell have always been a fundamental need in evolution and survival, psychological effects can be easily expected (25, 36–38). Consistent with other findings [e.g., (39)], women were more frequently affected by smell and taste disorders compared with men.

The COVID-19 pandemic issues such as the high risk of infection and reinfection, inadequate protection from contamination, overwork, frustration (i.e., witnessing death and feeling powerless over the levels of patient death, the delivery of patient care), discrimination, isolation, patients with negative

TABLE 4a | Hospital anxiety distress scores and olfactory/taste dysfunctions.

	Total cohort ($n = 104$)	Male ($n = 33$)	Female ($n = 71$)	*P*-value
HADS-A scores				
<8	72 (69.9%)	27 (81.8%)	45 (64.3%)	0.10
8–10	18 (17.5%)	5 (15.2%)	13 (18.6%)	
≥11	13 (12.6%)	1 (3.0%)	12 (17.1%)	
Not available	1 (1.0%)	0 (0.0%)	1 (1.4%)	
Median HADS-A score (min-max)	5 (0–18)	3 (0–16)	6 (0–18)	
HADS-D scores				
<8	83 (80.6%)	30 (90.9%)	53 (75.7%)	0.19
8–11	13 (12.6%)	2 (6.1%)	11 (15.7%)	
≥11	7 (6.8%)	1 (3.3%)	6 (8.6%)	
Not available	1 (1.0%)	0 (0.0%)	1 (1.4%)	
Median HADS-D score (min-max)	3 (0–18)	3 (0–18)	4 (0–14)	
HADS total scores				
<13	73 (70.8%)	28 (84.8%)	45 (64.3%)	0.06
≥13	30 (29.1%)	5 (15.2%)	25 (35.7%)	
Not available	1 (1.0%)	0 (0.0%)	1 (1.4%)	
Median HADS total score (min-max)	8 (0–34)	5 (1–34)	9 (0–31)	

TABLE 4b | Hospital anxiety distress scores and olfactory/taste dysfunctions.

	No olfactory dysfunction ($n = 19$)	Olfactory dysfunction ($n = 84$)	*P*-value
Olfactory dysfunctions			
HADS-A score			
Mean (SD)	3.7 (3.6)	6.0 (4.2)	0.018
Median (min-max)	2 (0–12)	5 (0–18)	
HADS-D score			
Mean (SD)	3.8 (3.1)	4.7 (3.6)	0.31
Median (Min-Max)	3 (1–13)	4 (0–18)	
HADS total			
Mean (SD)	7.5 (6.1)	10.6 (7.4)	0.06
Median (min-max)	5 (1–23)	8 (0–34)	
COVID-DT			
Mean (SD)	5.9 (2.8)	6.6 (2.5)	0.34
Median (min-max)	7 (2–10)	7 (0–10)	
Current DT			
Mean (SD)	3.4 (3.7)	4.1 (2.3)	0.29
Median (min-max)	2 (0–10)	4 (0–10)	

TABLE 4c | Hospital anxiety distress scores and olfactory/taste dysfunctions.

Taste dysfunctions	No taste dysfunction ($n = 25$)	Taste dysfunction ($n = 78$)	*P*-value
HADS-A			
Mean (SD)	3.4 (2.8)	6.3 (4.3)	0.002
Median (min-max)	3 (0–12)	6 (0–18)	
HADS-D			
Mean (SD)	3.2 (2.5)	5.0 (3.8)	0.02
Median (min-max)	2 (1–9)	4 (0–18)	
HADS total			
Mean (SD)	6.6 (4.3)	11.2 (7.7)	0.009
Median (min-max)	6 (1–20)	9 (0–34)	
COVID-DT			
Mean (SD)	5.3 (2.4)	6.9 (2.8)	0.005
Median (min-max)	6 (2–9)	7 (0–10)	
Current DT			
Mean (SD)	2.8 (2.7)	4.4 (3.0)	0.03
Median (min-max)	2 (0–8)	5 (0–10)	

TABLE 5 | Correlations between different psycogical distress scores.

Comparison	Spearman linear coefficient	*P*-value
COVID-DT vs. Current COVID	rho = 0.60	<0.001
COVID-DT vs. HADS-A	rho = 0.55	<0.001
COVID-DT vs. HADS-D	rho = 0.49	<0.001
COVID-DT vs. HADS total	rho = 0.56	<0.001

emotions, lack of contact with families, exhaustion, the incapacity of healthcare systems to respond to the increased demand (40–43) play an important role in patients' emotional experience, the co-existence of COVID-19 symptoms however may intensify their reactions and for the most induce anxiety disorders. In addition, even when people are healed, they continue to experience high emotional distress, especially because they are worried of getting sick again. In accordance with Lima et al. (44) and Duan and Zhu (45), this suggests the need for appropriate psychological interventions under pandemic conditions to prevent people from developing more serious or long-lasting psychological disorders and, as far as HCW, to reduce the risk of work related distress (42, 46–49).

LIMITATIONS

The study has some limitations. Data analysis was retrospective and did not fulfill the criteria of a randomized controlled study. Indeed, it is possible that individuals who adhered to be interviewed and completed the questionnaires were those who experienced greater psychological distress during the pandemic or who are simply more interested in psychological factors and implications. Another limitation might pertain the validity of the selected tools to investigate emotional distress related to the COVID pandemics. The DT and the HADS have been chosen as they are among the most widely used tests for screening and evaluating distress associated with organic diseases; however, they are not specifically designed for assessing emotional reactions during epidemics and/or pandemics, or for detecting their evolution over time as the pandemic continues; in addition, responses of COVID-DT can be influenced by recall bias. Finally, individuals' stress intensity has not been evaluated considering the duration of taste and smell disorders but taking into account only their presence or absence at the time of the interview. This aspect certainly deserves attention and could be investigated in-depth in future studies.

CONCLUSION

Anosmia and dysgeusia in people infected with COVID-19 are confirmed to increase psychological distress. Smell and taste dysfunctions can amplify psychological distress, and depressive symptoms are mostly associated with the loss of taste and tend to persist even after resolution of symptoms and disease. In this study, HCW reported high rates of emotional distress associated with COVID-19 infection and taste and smell dysfunctions. This highlights the importance of developing a systematic approach to identify at-risk individuals to prevent the development of more serious or long-lasting psychological disorders. Psychological interventions targeting HCW who contracted the COVID-19 infection, should be designed considering the symptom effects and job reintegration, which should take into account anxiety and depression experienced by workers who became ill. Interventions to benefit HCW, such as those suggested in the literature of psychological support, CBT, self-help strategies, and others, could be targeted to COVID-19 psychological effects. As well as the importance of collaboration in health care provider

support services between occupational doctors, occupational psychologists, and clinicians to study work-related risks.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comitato Etico Unico Regionale ARCS- FVG Nr. 0000611-P del 23/06/2020. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LD was the main author and lead researcher. CC and AL assisted in the conception of the research, recruitment of subjects, collection of data, and contributed to the writing-up of the manuscript. FG carried out statistical analyses of results and contributed to interpretation of the final conclusions. GA, IS, VB, and MP helped in the recruitment of subjects and carried out the interviews. VP, PM, FR, BG, and CN supervised the project and discussed the findings of this work. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.666442/full#supplementary-material

REFERENCES

1. COVID-19 Treatment Guidelines Panel. *Coronavirus Disease 2019 (COVID-19) Treatment Guidelines (2019). National Institutes of Health*. Available online at: https://www.covid19treatmentguidelines.nih.gov/ (accessed December 17, 2020).
2. Chow EJ, Schwartz NG, Tobolowsky FA, Zacks RLT, Huntington-Frazier M, Reddy SC, et al. Symptom screening at illness onset of health care personnel with sars-cov-2 infection in king county, Washington. *JAMA*. (2020) 323:2087. doi: 10.1001/jama.2020.6637
3. Clemency BM, Varughese R, Scheafer DK, Ludwig B, Welch JV, McCormack RF, et al. Symptom criteria for COVID-19 testing of heath care workers. *Acad Emerg Med*. (2020) 27:469–74. doi: 10.1111/acem.14009
4. Esakandari H, Nabi-Afjadi M, Fakkari-Afjadi J, Farahmandian N, Miresmaeili, S.-M., et al. A comprehensive review of COVID-19 characteristics. *Biol Proced Online*. (2020) 22:1–10. doi: 10.1186/s12575-020-00128-2
5. Gengler I, Wang JC, Speth MM, Sedaghat AR. Sinonasal pathophysiology of SARS-CoV−2 and COVID−19: a systematic review of the current evidence. *Laryngoscope Investig Otolaryngol*. (2020) 5:354–9. doi: 10.1002/lio2.384
6. Gilani S, Roditi R, Naraghi M. COVID-19 and anosmia in Tehran, Iran. *Med Hypotheses*. (2020) 141:109757. doi: 10.1016/j.mehy.2020.109757
7. Lechien JR, Chiesa-Estomba CM, De Siati DR, Horoi M, Le Bon SD, Rodriguez A, et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease (COVID-19): a multicenter European study. *Eur Arch Oto-Rhino-Laryngology*. (2020) 277:2251–61. doi: 10.1007/s00405-020-06024-5
8. Villalba NL, Maouche Y, Ortiz MBA, Sosa ZC, Chahbazian JB, Syrovatkova A., et al. Anosmia and dysgeusia in the absence of other respiratory diseases: should COVID-19 infection be considered? *Eur J Case Rep Intern Med*. (2020) 7:001641. doi: 10.12890/2020_001641
9. Boscolo-Rizzo P, Borsetto D, Fabbris C, Spinato G, Frezza D. Menegaldo, et al. Evolution of altered sense of smell or taste in patients with mildly symptomatic COVID-19. *JAMA Otolaryngol Head Neck Surg*. (2020) 146:729. doi: 10.1001/jamaoto.2020.1379
10. Lechner M, Chandrasekharan D, Jumani K, Liu J, Gane S, Lund VJ, et al. Anosmia as a presenting symptom of SARS-CoV-2 infection in healthcare workers-a systematic review of the literature, case series, and recommendations for clinical assessment and management. *Rhinology*. (2020) 58:394–99. doi: 10.4193/Rhin20.189
11. Lechner M, Patel ZM, Philpott C, Lund VJ. Olfactory loss of function as a possible symptom of COVID-19. *JAMA Otolaryngol Head Neck Surg*. (2020) 146:872–3. doi: 10.1001/jamaoto.2020.1589
12. Mao L, Jin H, Wang M, Hu Y, Chen S, He Q, et al. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurol*. (2020) 77:683–90. doi: 10.1001/jamaneurol.2020.1127
13. Mercante G, Ferreli F, De Virgilio A, Gaino F, Di Bari M, Colombo G, et al. Prevalence of taste and smell dysfunction in coronavirus disease 2019. *JAMA Otolaryngol Head Neck Surg*. (2020) 146:723–8. doi: 10.1001/jamaoto.2020.1155
14. Spinato G, Fabbris C, Polesel J, Cazzador D, Borsetto D, Hopkins C, et al. Alterations in smell or taste in mildly symptomatic outpatients with SARS-CoV-2 infection. *JAMA*. (2020) 323:2089–90. doi: 10.1001/jama.2020.6771
15. Wilson MP, Jack AS. Coronavirus disease (COVID-19) in neurology and neurosurgery: a scoping review of the early literature. *Clin Neurol Neurosurg*. (2020) 193:105866. doi: 10.1016/j.clineuro.2020.105866
16. Wong TW, Yau JK, Chan CL, Kwong RS, Ho SM, Lau CC, et al. The psychological impact of severe acute respiratory syndrome outbreak on healthcare workers in emergency departments and how they cope. *Eur J Emerg Med*. (2005) 12:13–8. doi: 10.1097/00063110-200502000-00005
17. Carmassi C, Foghi C, Dell'Oste V, Cordone A, Bertelloni CA, Bui E, et al. PTSD symptoms in healthcare workers facing the three coronavirus outbreaks: what can we expect after the COVID-19 pandemic. *Psychiatry Res*. (2020) 292:113312. doi: 10.1016/j.psychres.2020.113312
18. Di Tella M, Romeo A, Benfante A, Castelli L. Mental health of healthcare workers during the COVID-19 pandemic in Italy. *J Eval Clin Pract*. (2020) 26:1583–87. doi: 10.1111/jep.13444
19. Holmes EA, O'Connor RC, Perry VH, Tracey I, Wessely S, Arseneault L, et al. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *Lancet Psychiatry*. (2020) 7:547–60. doi: 10.1016/S2215-0366(20)30168-1
20. Stuijfzand S, Deforges C, Sandoz V, Sajin CT, Jaques C, Elmers J, et al. Psychological impact of an epidemic/pandemic on the mental health of healthcare professionals: a rapid review. *BMC Public Health*. (2020) 20:1–18. doi: 10.1186/s12889-020-09322-z

21. Li W, Yang Y, Liu ZH, Zhao YJ, Zhang Q, Zhang L, et al. Progression of mental health services during the COVID-19 outbreak in China. *Int J Biol Sci.* (2020) 16:1732. doi: 10.7150/ijbs.45120
22. Xiong J, Lipsitz O, Nasri F, Lui LM, Gill H, Phan L, et al. Impact of COVID-19 pandemic on mental health in the general population: A systematic review. *J Affect Disord.* (2020) 277:55–64. doi: 10.1016/j.jad.2020.08.001
23. Rajkumar RP. COVID-19 and mental health: a review of the existing literature. *Asian J Psychiatry.* (2020) 52:102066. doi: 10.1016/j.ajp.2020.102066
24. Russell B, Moss C, Rigg A, Hopkins C, Papa S, Van Hemelrijck. M. (2020) Anosmia and ageusia are emerging as symptoms in patients with COVID-19: what does the current evidence say? *Ecancermedicalscience.* (2020) 14:ed98. doi: 10.3332/ecancer.2020.ed98
25. Tennen H, Affleck G, Mendola R. Coping with smell and taste disorder. In: Getchell TV, Doty RL, Bartoshuk LM, Snow JB, editors. *Smell and Taste in Health and Disease*. New York, NY: Raven Press (1991). p. 787–802.
26. Heath TP, Melichar JK, Nutt DJ, Donaldson LF. Human taste thresholds are modulated by serotonin and noradrenaline. *J Neurosci.* (2006) 26:12664–71. doi: 10.1523/JNEUROSCI.3459-06.2006
27. Weiffenbach JM, Bartoshuk LM. Taste and smell. *Clin Geriatr Med.* (1992) 8:543–56. doi: 10.1016/S0749-0690(18)30463-4
28. Public health surveillance for COVID-19: interim guidance. World Health Organization (2020). Available online at: https://www.who.int/publications/i/item/who-2019-nCoV-surveillanceguidance-2020.7 (accessed December 16, 2020).
29. Donovan KA, Grassi L, McGinty HL, Jacobsen PB. Validation of the distress thermometer worldwide: state of the science. *Psychooncology.* (2014) 23:241–50. doi: 10.1002/pon.3430
30. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica.* (1983) 67:361–70. doi: 10.1111/j.1600-0447.1983.tb09716.x
31. Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the hospital anxiety and depression scale. *J Psychosom Res.* (2002) 52:69–77. doi: 10.1016/S0022-3999(01)00296-3
32. Tesio V, Molinaro S, Castelli L, Andriani M, Fanelli AL, Marra S, et al. Screening of depression in cardiac patients: is the HADS an effective tool? *Int J Cardiol.* (2014) 172:e344–5. doi: 10.1016/j.ijcard.2013.12.308
33. Di Stasio D, Candotto V, Serpico R, Migliozzi R, Petruzzi M, Tammaro M, et al. Depression and distress in burning mouth syndrome: a case control study. *J Biol Regul Homeost Agents*. (2018) 32(2 Suppl. 1):91–5.
34. Canaletti C, Colombo F, Dessì A, Geccherle E, Tongiorgi A, Cai P, et al. *Depressive symptoms and anxiety and their screening in IBD patients: performance of the distress thermometer in Italian IBD patients*. Abstracts of the 15th Congress of ECCO—European Crohn's and Colitis Organisation, Vienna 2020 (2020).
35. Grassi L, Johansen C, Annunziata MA, Capovilla E, Costantini A, Gritti P, et al. Screening for distress in cancer patients: a multicenter, nationwide study in Italy. *Cancer.* (2013) 119:1714–21. doi: 10.1002/cncr.27902
36. Croy I, Nordin S, Hummel T. Olfactory disorders and quality of life—an updated review. *Chem Senses.* (2014) 39:185–94. doi: 10.1093/chemse/bjt072
37. Wang L, Gillis-Smith S, Peng Y, Zhang J, Chen X, Salzman CD, et al. The coding of valence and identity in the mammalian taste system. *Nature.* (2018) 558:127–31. doi: 10.1038/s41586-018-0165-4
38. Rolls ET. Taste and smell processing in the brain. In: Doty RL, editor. *Handbook of Clinical Neurology*. Amsterdam: ELSEVIER (2019). p. 97–118.
39. Printza A, Constantinidis J. The role of self-reported smell and taste disorders in suspected COVID-19. *Eur Arch Oto-Rhino-Laryngology.* (2020) 277:2625–30. doi: 10.1007/s00405-020-06069-6
40. Giorgi G, Lecca LI, Alessio F, Finstad GL, Bondanini G, Lulli LG, et al. COVID-19-Related mental health effects in the workplace: a narrative review. *Int J Environ Res Public Health.* (2020) 17:7857. doi: 10.3390/ijerph17217857
41. Kang L, Li Y, Hu S, Chen M, Yang C, Yang BX, et al. The mental health of medical workers in Wuhan, China dealing with the 2019 novel coronavirus. *Lancet Psychiatry.* (2020) 7:e14. doi: 10.1016/S2215-0366(20)30047-X
42. Pollock A, Campbell P, Cheyne J, Cowie J, Davis B, McCallum J, et al. Interventions to support the resilience and mental health of frontline health and social care professionals during and after a disease outbreak, epidemic or pandemic: a mixed methods systematic review. *Cochrane Database Syst Rev.* (2020) 11:CD013779. doi: 10.1002/14651858.CD013779
43. Preti E, Di Mattei V, Perego G, Ferrari F, Mazzetti M, Taranto P, et al. The psychological impact of epidemic and pandemic outbreaks on healthcare workers: rapid review of the evidence. *Curr Psychiatry Rep.* (2020) 22:1–22. doi: 10.1007/s11920-020-01166-z
44. Lima CKT, De Medeiros Carvalho PM, Lima IDAAS, de Oliveira Nunes JVA, Saraiva JS, et al. The emotional impact of Coronavirus 2019-nCoV (new Coronavirus disease). *Psychiatry Research.* (2020) 287:112915. doi: 10.1016/j.psychres.2020.112915
45. Duan L, Zhu G. Psychological interventions for people affected by the COVID-19 epidemic. *Lancet Psychiatry.* (2020) 7:300–2. doi: 10.1016/S2215-0366(20)30073-0
46. De Pablo GS, Vaquerizo-Serrano J, Catalan A, Arango C, Moreno C, Ferre F, et al. Impact of coronavirus syndromes on physical and mental health of health care workers: Systematic review and meta-analysis. *J Affect Disord.* (2020) 275:48–57. doi: 10.1016/j.jad.2020.06.022
47. Giusti EM, Pedroli E, D'Aniello GE, Stramba Badiale C, Pietrabissa G, Manna C, et al. The psychological impact of the COVID-19 outbreak on health professionals: a cross-sectional study. *Front Psychol.* (2020) 11:1684. doi: 10.3389/fpsyg.2020.01684
48. Magnavita N, Tripepi G, Di Prinzio. R. R. Symptoms in health care workers during the COVID-19 epidemic. A cross-sectional survey. *Int J Environ Res Public Health.* (2020) 17:5218. doi: 10.3390/ijerph17145218
49. Shanafelt T, Ripp J, Trockel M. Understanding and addressing sources of anxiety among health care professionals during the COVID-19 pandemic. *JAMA.* (2020) 323:2133–4. doi: 10.1001/jama.2020.5893

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Occupational Disorders, Daily Workload, and Fitness Levels Among Fitness and Swimming Instructors

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Few data have been published on occupational disorders among sports instructors, especially regarding those who are expected to continuously practice while teaching. As the number of sports instructors increases, new specific information about their possible injuries, daily workload, and fitness levels is needed. The aim of this study was to assess occupational disorders, cardiorespiratory fitness, and daily workload of fitness (FI) and swimming instructors (SI). An online survey addressing occupational disorders was conducted among 435 instructors (256 FI and 179 SI). In one subgroup (57 FI and 42 SI), cardiorespiratory fitness levels were evaluated using maximal oxygen consumption ($\dot{V}O_{2max}$) as an indicator. Daily workload was assessed by monitoring the heart rate and perception of exertion (using the Borg scale). Of the two groups, FI exhibited a higher 2-year prevalence of musculoskeletal injuries and SI experienced more upper respiratory tract infections. $\dot{V}O_{2max}$ ranged from 47.0 to 51.9 $ml \cdot kg^{-1} \cdot min^{-1}$ and was similar for both FI and SI. Regarding the daily workload, female SI had significantly higher mean heart rate and mean heart rate to maximal heart rate ratio compared to female FI, but no significant differences between male FI and SI were found. No significant differences were observed between the perceived exertion of FI and SI. Preventive strategies for the reduction of occupational disorders in FI and SI are needed.

Keywords: occupational disorder, cardiopulmonary assessment, rate of perceived exertion, musculoskeletal disorders, heart rate monitoring

INTRODUCTION

The fitness industry is booming: the last 10 years have shown a rapid increase in the number of fitness club members and employees, with almost 750,000 fitness employees in Europe alone (1). In particular, the fitness industry includes both fitness and/or swimming pool centers. In fitness centers, customers can find lots of equipment for cardio and weight training or group fitness classes. In swimming pool centers, customers can find different types of swimming classes as well as water aerobics courses. Fitness (FI) and swimming instructors (SI) are the two different types of trainers usually employed at these centers. FI generally lead, instruct, and motivate individuals or groups in exercise activities, including cardiovascular exercises, strength training, and stretching. Typically,

FI work with individual clients to design, explain, and demonstrate various exercises and routines, or they teach group classes where they organize and lead fitness lessons lasting 30–90 min. In these classes, instructors may set the music and choreography to exercise sequences, while often also using specific exercise equipment (e.g., stationary bicycles, weights, etc.). SI generally help people learn how to swim, improve swimming skills, and exercise in water. Moreover, they are also specialized in teaching water aerobics classes during which they perform aerobic exercises along with the water-immersed participants. These classes focus on aerobic endurance, creating an enjoyable atmosphere with music.

Both FI and SI professions are physically demanding. Most of the time, FI and SI find themselves having to carry out the exercises themselves while teaching, and they may work nights, weekends, holidays, and may even have to travel to different gyms or to clients' homes to teach classes or to conduct personal training sessions. However, despite the numerous health-related advantages of physical activity and exercise, the risk of occupational disorders among FI and SI has been poorly addressed by academic research. To date, a high prevalence of musculoskeletal injuries in FI has been described (2–7): most of the injuries were to lower arms and lower back (12.9%), and they were associated with the number of times per week the instructors exercised. No clear relationship between musculoskeletal disorders and sex has been uncovered thus far (7).

In addition to overall stress on the musculoskeletal system, FI and SI actively have to make use of their voices during classes and rely on their voices in a similar way that vocal performers, classroom teachers, salespeople, and others in vocally demanding professions do (8). FI and SI have reported voice difficulties that appear to be the result of an interaction between both environmental and physiological stress placed on the voice given that speaking/shouting and vigorous exercise often have to occur simultaneously during classes (9–11). Indeed, for FI and SI the voice is an essential professional asset used not only to provide education and direction but also to motivate and encourage class participants to persevere (12). The vocal effectiveness of the instructor has a direct influence on the satisfaction of clients and keeps them motivated to return. Furthermore, the amount and type of verbal motivation required are often driven by the fitness genre (8). There are also several factors that can add additional vocal strain, because instructors often vocalize with music and other noise sources in the background and often teach in acoustically poor spaces (12). As such, several papers found that fitness instructors experienced more hoarseness and episodes of voice loss during and after instructing and had a significantly higher prevalence of laryngeal nodules (8, 9, 12). Finally, gender was shown to impact the occurrence of vocal disorders with females being most commonly affected (13).

Since studies on the occupational disorders experienced by FI and SI are limited, the primary purpose of this study was to investigate the 2-year prevalence of occupational disorders experienced by FI and SI employed in various fitness center companies through a self-reported questionnaire. In addition, we assessed the fitness levels, workloads, and perceived exertion during a typical workday of SI and FI in order to explore the possible factors associated with occupational disorders in these occupations. In particular, the possible effects of sex, instructor type, and years of work experience on the observed occupational disorders were considered.

METHODS

Study Design

In order to assess the 2-year prevalence of occupational disorders experienced by FI and SI, a retrospective, cross-sectional, self-reporting study was conducted. Subsequently, to investigate physical fitness and daily workload during a typical workday of FI and SI, a prospective, cross-sectional, substudy was performed. The outcome of the study was the prevalence of occupational disorders among FI and SI. We calculated a sample size taking the expected proportion of cases from previous literature data on musculoskeletal (7) and vocal disorders (8–11, 13) among FI. The calculation led to a corresponding number of 270 and 354 individuals, respectively (which included a predicted 20% rejection rate), which was needed to estimate the prevalence of musculoskeletal and vocal disorders.

Participant Screening

Participants were recruited from various fitness centers located in the North of Italy. These centers employed both FI (e.g., dance aerobics, step aerobics, spinning, pilates, yoga, low-back pain exercise classes, strength training, boxing/kickboxing) and SI (e.g., water aerobics, swimming courses, mother/baby swimming courses). The questionnaires were collected from 2008 to 2010 by activating the communication channels of the sports centers and getting University students of the Faculty of Exercise Sciences in Milan to directly contact their colleagues at the sports centers where they attended classes. The inclusion criteria were being an FI or SI instructor and teaching a minimum of one class a week. The exclusion criterion was being unable to fill out the questionnaire, of which the English translation can be found in the **Supplementary Material**. Potential participants' e-mail addresses were provided by the head of each center. The responders were contacted by email where they were fully informed about the study's procedures and the benefits and risks associated with participation. A consent form was sent to the participant *via* e-mail which then had to be signed and e-mailed back by the participant. At this point, the online survey was e-mailed to the participant who had agreed to participate and met the above inclusion criteria. Participants who agreed to also participate in the next part of the study (i.e., the physical fitness assessment) were contacted by phone to organize the laboratory testing and daily workload monitoring.

The Online Survey

The online survey was created according to the guidelines provided by Artino et al. (14). Subjects were requested to complete the survey within a 2-week period. The data retrieved from the online questionnaires was subsequently entered in a protected database, from which the data was reorganized in tabular form for the purpose of descriptive statistics. The survey

requested information regarding personal physical data as well as the frequency, duration, and time period (early morning, morning, afternoon, or evening) of class participation. For the purposes of this study, all self-reported occupational disorders related to their work during the last 2 years were asked by having the participant answer the following question: "Have you experienced any occupational disorder as a FI or SI during the last 2 years?" (7). In the case of a positive response, participants had to specify each injury and the type of injury (acute/overuse) in accordance with the definitions provided by a consensus statement regarding disorder registration (15). A "disorder" was defined as any condition causing pain and/or limiting activity. Only those participants who saw a physician for their disorders were asked to report a diagnosis. Participants who did not see a physician were asked to report the location of the disorder. The extent of the disorder was examined by contingency questions regarding the limitation(s) that the injury placed on activity. The survey took 20–25 min to fill out.

Physical Fitness Assessment

Participants' physical fitness was assessed using maximal oxygen consumption assessment ($\dot{V}O_{2max}$) in the laboratory of the University of Milan upon individual appointment.

The cardiopulmonary exercise testing was performed after the physical assessment session during work in order to avoid the possible carryover effect of fatigue on the subsequent working days. Oxygen consumption ($\dot{V}O_2$), carbon dioxide production ($\dot{V}CO_2$), and pulmonary ventilation ($\dot{V}E$) were measured using a metabolic device on a breath-by-breath basis (Quarkb^2, Cosmed, Rome, Italy) during a graded ramp cycle ergometer test (Monark Ergomedic mod. 839E, Monark, Vansbro, Sweden). All tests were carried out in a well-ventilated laboratory under standardized

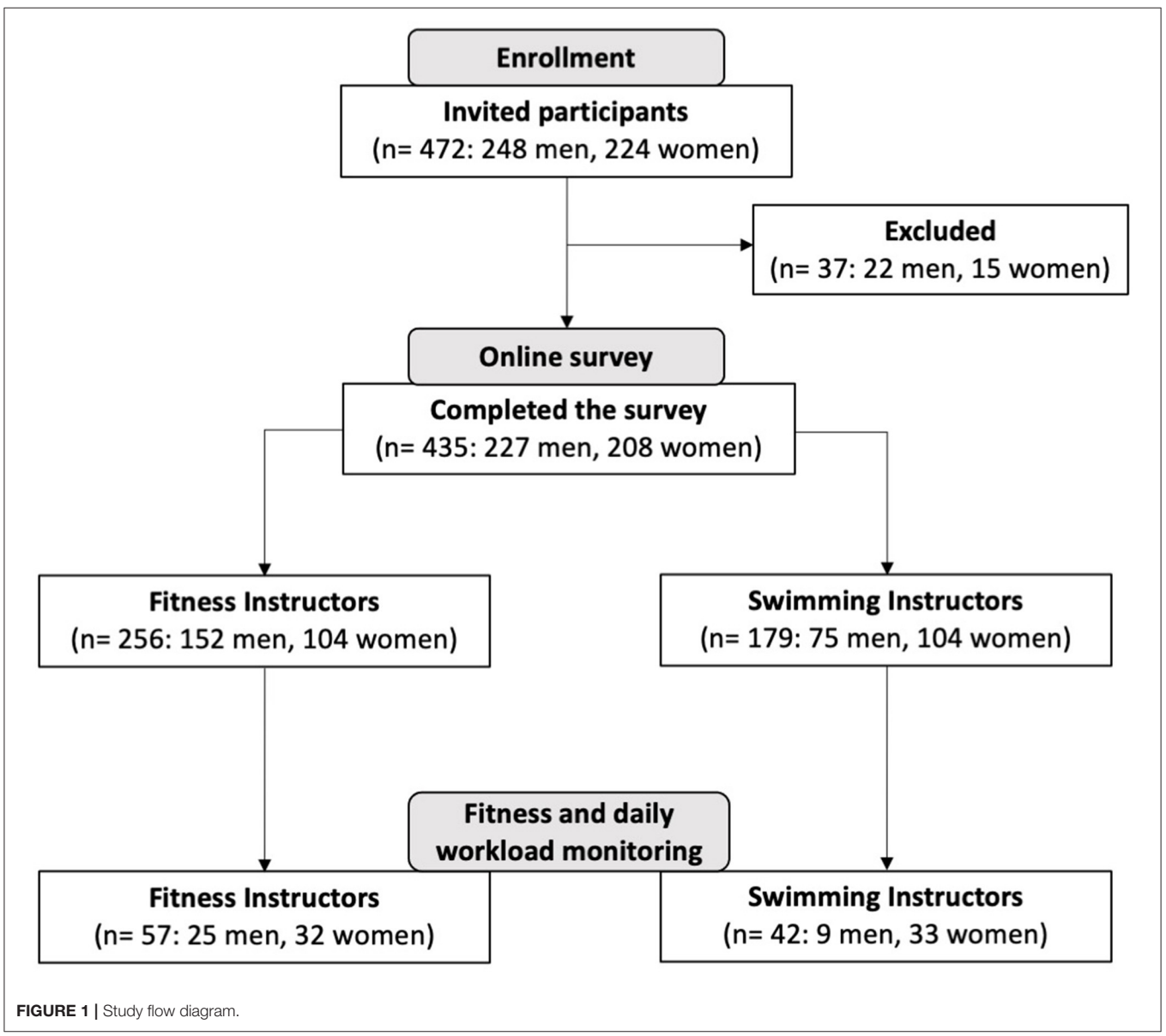

FIGURE 1 | Study flow diagram.

TABLE 1 | Results of whole sample questionnaires regarding demographics and job characteristics.

	FI	SI
Demographic and general characteristics		
All (*n*)	256	179
Men (*n*, %)	152, 59	75, 41
Women (*n*, %)	104, 41	104, 59
Age (years)	28 ± 7	30 ± 8
Height (m)	1.73 ± 0.08	1.70 ± 0.09
Body mass (kg)	67.3 ± 12.1	64.5 ± 11.5
BMI ($kg \cdot m^{-2}$)	22.2 ± 2.4	22.1 ± 2.7
Job type		
FI/SI as main occupation (%)	41	46
FI/SI as secondary occupation (%)	59	54
Career duration		
<5 years (%)	52	41*
5–10 years (%)	33	31
>10 years (%)	15	28**
Weekly working hours		
<10 h (%)	51	31**
10–30 h (%)	37	54**
>30 h (%)	12	15

*FI, fitness instructors; SI, swimming instructors. *p < 0.05 between groups; **p < 0.01 between groups.*

constant ambient conditions (i.e., a temperature of 22 ± 2°C and humidity of <70%). The protocol consisted of 3 min at 50 W/min (warm-up and familiarization), followed by an increase of 20 W every min until exhaustion. Achievement of $\dot{V}O_{2max}$ was considered as the attainment of at least two of the following criteria: (1) a plateau of $\dot{V}O_2$ levels despite increasing speed; (2) a respiratory exchange ratio above 1.1; and (3) a heart rate (HR) of ±10 bpm of age-predicted maximal HR (i.e., 220−age) (16). HR was recorded during the entire test using an HR monitor (Polar RS800, Polar Electro, Kempele, Finland). Maximal HR at exhaustion was considered as HR_{max}.

Daily Workload Monitoring

Each participant was equipped with the HR monitor and instructed to wear it during their typical workday for 1 week. We then evaluated the day of greatest work commitment of the week for each individual, from which we retrieved the HR during the peak 3 h of the effective work hours. HR recordings were expressed as the percentage of the maximum value (% HR_{max}) reached during the maximal oxygen consumption assessment. All the HRs obtained were then compared to the American College of Sports Medicine's recommendations (17) for the development of aerobic fitness, which define the relationship between work HR ranges and work intensity. Participants were asked to continue their normal daily working routine and to maintain their usual diets during the monitoring period.

Rating of Perceived Exertion Assessment

The Borg CR100 scale (18) was selected to rate the perceived exertion of a typical lesson. A verbal-anchored scale was provided to the participants who were instructed to use it 30 min after the end of their workday. Each participant was preliminary familiarized with the Borg CR100 scale, including anchoring procedures.

Statistical Analysis

Respondents with missing data were excluded from the analysis. Descriptive statistics (mean ± standard deviation) for the outcome measures were calculated. The normality of the distribution was checked using the Kolmogorov–Smirnov test. Since all anthropometric variables were normally distributed, differences between male and female FI and SI were checked using an unpaired Student's *t*-test. A Chi-square test was used to compare the questionnaire's variables of educational level, professional information, and job characteristics between FI and SI groups. Differences between the perceived exertion after the maximally fatiguing workday and the perceived exertion 30 min after the end of the lessons of FI and SI were studied using the Student's paired *t*-test. Intra- and intergroup differences (gender × instructor type) for $\dot{V}O_{2max}$, HR_{mean}, and HR_{max} between daily workload for FI and SI were checked using two-way analysis of variance with Bonferroni's multiple-comparison test. The level of statistical significance was set at $p < 0.05$. Statistical analysis was performed using the software STATISTICA (version 7.1, StatSoft, Tulsa, OK, USA).

RESULTS

Participant Screening Results

The study population included 472 participants of which 435 instructors completed the online survey, (response rate: 92.2%). Ninety-nine subjects (57 FI and 42 SI) agreed to also participate in the next phase of the study during which their fitness level, workload monitoring, and perceived exertion of a typical workday were measured. The design of the study is shown in **Figure 1**.

Online Survey Results

Table 1 shows the demographics of the participants. The participants in each group were similar in age, height, body mass, and body mass index (BMI). Only a small percentage of the participants had been active in their profession >10 years. The number of weekly work hours was <10 h for more than half of all FI and between 10 and 30 h per week for all SI. The presence of preexisting pathologies was not investigated in this study. Most of the participants (∼70%) stated that they partake in both competitive and/or noncompetitive sports outside of their profession for an average of 5.4 ± 4.2 h per week. In Italy, SI and FI are obligated to obtain annual certificates of good health from a sports medicine physician in order to practice their profession. The annual visit includes an accurate medical history, an ECG at rest (and during exercise in case of agonistic activity), a spirometric evaluation, and a clinical physical examination.

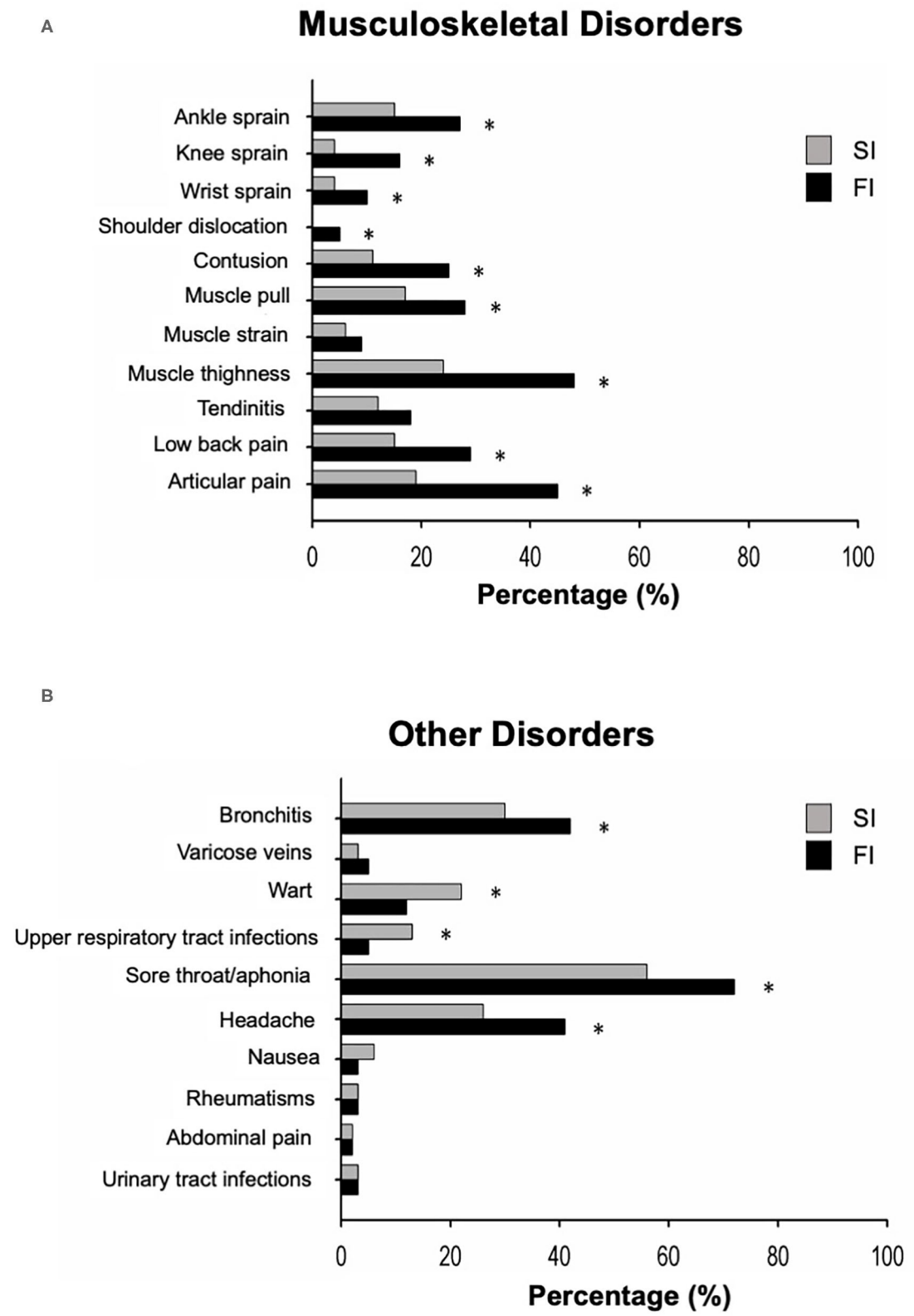

FIGURE 2 | The figure represents the proportion of individuals in the swimming and fitness instructor groups (SI, swimming instructors, $n = 179$; FI, fitness instructors, $n = 256$), who experienced specific musculoskeletal injury **(A)** or other disorders **(B)** in the last 2 years. *$p < 0.05$ between groups.

TABLE 2 | Physiological variables during maximal oxygen consumption ($\dot{V}O_{2max}$) assessment and heart rate (HR) data during daily workload monitoring of fitness instructors (FI) and swimming instructors (SI).

Parameter	Males		Females	
	FI ($n = 25$)	SI ($n = 9$)	FI ($n = 32$)	SI ($n = 33$)
Exercise test				
HR_{rest} (beats·min^{-1})	66 ± 14	62 ± 14	66 ± 13	65 ± 10
HR_{max} (beats·min^{-1})	186 ± 5	186 ± 4	187 ± 4	187 ± 5
$\dot{V}O_{2max}$ (mL·kg^{-1}·min^{-1})	51.9 ± 3.7	50.9 ± 3.8	48.9 ± 3.6	47.0 ± 4.0
Daily HR recording				
HR_{mean} (beats·min^{-1})	127 ± 28	144 ± 6	126 ± 21	139 ± 19*
HR_{mean}/HR_{max}	0.69 ± 0.14	0.78 ± 0.40	0.68 ± 0.11	0.75 ± 0.10*

*$p < 0.05$ between groups.

Overall, a total of 621 musculoskeletal disorders and 521 other types of disorders were reported in the study of 157 FI (61% of 256 FI who completed the survey) and 155 SI (86% of 179 SI who completed the survey), that experienced two or more injuries during the last 2 years. **Figure 2** illustrates the 2-year prevalence of occupational disorders that occurred in the FI and SI careers, divided into musculoskeletal and other disorders. The percentages of ankle, knee, and wrist sprains, shoulder dislocations, contusions, muscle pulls and contractures, lower back pain, and articular pain were significantly higher in the FI group vs. the SI group ($p = 0.032$). Non-musculoskeletal diseases such as bronchitis, sore throat/aphonia, and headache were significantly more common in the FI group ($p = 0.014$), whereas warts and upper respiratory tract infections were more frequent in the SI group ($p = 0.025$).

Physical Fitness Results and Daily Workload Monitoring Results

FI and SI groups did not differ significantly in $\dot{V}O_{2max}$. The FI and SI $\dot{V}O_{2max}$, HR at rest, and HR_{max} classified by sex and instructor type are shown in **Table 2**. FI and SI groups did not differ significantly in $\dot{V}O_{2max}$, HR at rest, and HR_{max}, and no interaction between sex and instructor type was observed between groups. Additionally, the HR_{mean} during 3 h of a typical workday and the ratio between HR_{mean} and HR_{max} are shown in **Table 2**. While there was no significant main effect found between male SI and FI, the female SI displayed significantly higher HR_{mean} and HR_{mean}/HR_{max} than the female FI did ($p = 0.018$, $p = 0.022$, respectively).

Rating of Perceived Exertion Results

The perceived level of exertion after a typical workday was 72.3 ± 16.2 AU (i.e., arbitrary units in the CR100 scale, a point scale up to 100 with 100 being the maximum possible level of exertion) (18) in FI and 72.0 ± 18.0 AU in SI, with no significant differences between the groups. **Figure 3** shows the perceived physical exertion of a typical lesson conducted by FI and SI. About 50% of the SI group and 60% of the FI group reported feeling that their typical lesson was physically "hard," with no significant differences between groups. A significantly higher percentage of SI participants described the physical exertion of their lesson as "very hard" ($p = 0.042$ between groups, χ^2 test for percentages).

DISCUSSION

To the best of our knowledge, the present study is one of the first that investigated the prevalence of occupational disorders among FI and SI. In particular, we observed that FI had a higher 2-year prevalence of musculoskeletal occupational disorders, whereas SI experienced more acute and chronic voice disorders. Moreover, since FI and SI have to cope with physical exertion and psychological stress, we have provided objective data on their physical fitness level and workload during a typical workday.

Regarding musculoskeletal disorders, we observed that muscle tightness (i.e., a shortening of a muscle), ankle, knee, and wrist sprains, shoulder dislocations, contusions, low-back pain, and articular pain were very common among FI. Our results are in line with previous findings on FI occupational health (3–5, 7, 19). Hickey and Hager (19) showed that the most common chronic injuries in aerobic dance instructors were tendinitis, repetitive strain injury, patello-femoral diseases, and medial tibial syndromes, followed by ankle sprain and low-back pain, as suggested by Rothenberger et al. (3). Also, du Toit et al. (4) and Bratland-Sanda et al. (7) reported that the lower-limb injuries were very common, with the ankle (32.8%) and the knee (20%) being the most common sites of injury. Generally, these types of injuries are classified as overuse injuries, resulting from repetitive force applied to a tissue, joint, or ligament. Bratland-Sanda (7) stated that the greater risk of lower-limb musculoskeletal disorders in FI is related to the monotonous exercise modality, which is a primary risk factor for overuse injuries. In addition, Sohl and Bowling (17) reported high-intensity training classes, unsuitable floors, shoe type, high number of workouts per day, difficult choreography, and insufficient warm-up as the factors that may contribute to more occupational disorders of the lower limbs. Finally, Scharff-Olson (20) indicated that the number of weekly classes was an additional variable associated with musculoskeletal disorders. In fact, four aerobic dance sessions per week increased the injury incidence from 43% to 66% compared to subjects who exercised three times per week or less (20). On the contrary, we found that SI had a lower prevalence of musculoskeletal occupational disorders. This was not unexpected seeing as SI work is largely done standing (e.g., classic swim classes) or is anti-gravitational (e.g., during water immersed aerobic classes).

With regard to the other disorders, the present investigation found that both FI and SI are at a higher risk of developing both acute and chronic voice difficulties associated with the development of sore throat, aphonia, and bronchitis. These results corroborate previous research that found that 58 and 12% of group fitness instructors experience hoarseness and voice loss immediately following classes (20). It seems reasonable to associate these disorders with the typical demands of the job that require loud verbal instructions while performing exercises, thereby making the control of

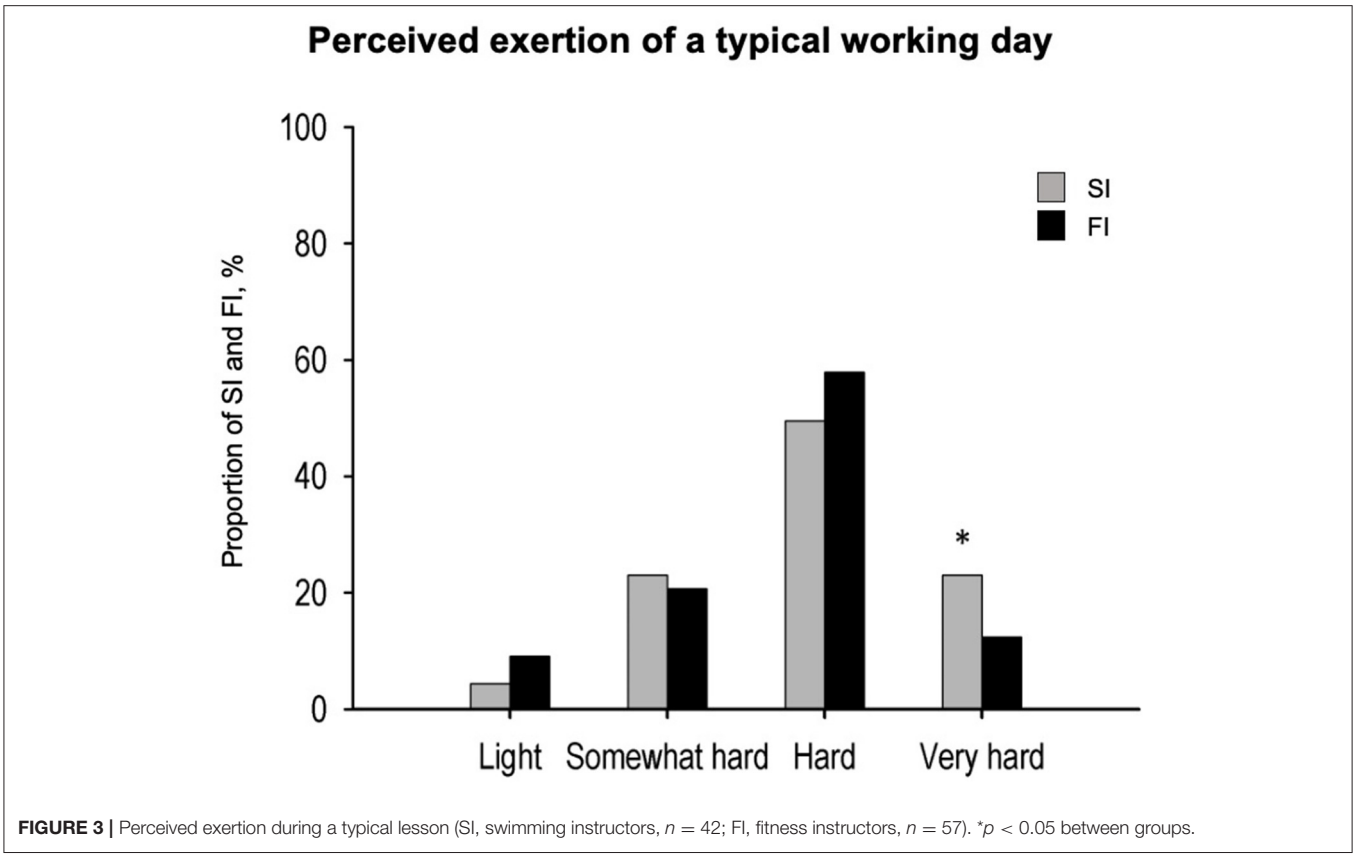

FIGURE 3 | Perceived exertion during a typical lesson (SI, swimming instructors, $n = 42$; FI, fitness instructors, $n = 57$). *$p < 0.05$ between groups.

breathing and airflow movement more stressful. Indeed, it has been demonstrated that the interaction between both environmental and physiological stress leads FI and SI to assume a hyperfunctional behavior that could also be worsened by postural misalignment, breathing patterns, and work environment and therefore lead to the adoption of compensatory vocal behaviors (21). This has been observed especially in young and inexperienced instructors who risk developing voice overuse and laryngeal diseases in the long run (22). Another incidental factor may be the poor air quality (e.g., dryness, dust) in the workplace that may cause allergic reactions or sinus infections (23). Finally, the use of chlorine-based products to sanitize swimming water in daily life may affect the respiratory health of SI (24). Moreover, we observed that SI are at a higher risk to develop headache and warts compared to FI. Regarding headaches, we hypothesize that the warm temperatures and humidity typical of swimming pool environments may play a role, especially in individuals prone to migraine attacks (25). Regarding warts, it is well known that swimming pools may be a more favorable environment for these types of infections (26).

Regarding the fitness level assessment, we are now able to provide evidence of the physical fitness and daily workload of FI and SI. In particular, we found that FI and SI showed the same $\dot{V}O_{2max}$ during a graded maximal test and HR during a typical workday. Therefore, the aerobic fitness level was comparable between FI and SI subjects, suggesting that both groups are probably exposed to a similar workload, and thus training, during a workday. Our results are similar to those found in the study of Wanke et al. (27), who assessed the work-related cardiovascular loads in professional dance teachers. They found that, depending on the dance style (e.g., jazz, modern dance, ballet, etc.), the average HR load during the lessons ranged between 56.7 and 63.6% of the individual HR_{max}. Interestingly, we found a significantly higher HR_{mean} in women during a typical workday in SI with respect to FI. We could therefore speculate that female SI are more often involved in aqua gym classes or similar training sessions, which require active physical participation from the instructor, whereas male SI are more likely to be devoted to swimming instruction or training, which does not include active physical involvement.

This study had some limitations. Firstly, the questionnaire we used was custom-made and has not yet been validated nor checked for internal consistency. After its design, the questionnaire was only submitted to a small group of fitness experts, who evaluated whether the questions effectively captured the topic under investigation. The data obtained with this questionnaire should therefore be considered as pilot data.

Secondly, due to the paucity of research in this area, the first part of this study was designed as a cross-sectional and exploratory study. Although this design is less expensive and can be performed within a shorter period of time, some confounding factors such as history of injuries and work habits prior to data collections cannot be controlled. Therefore, antecedent–consequent relationships as well as occupational disorders and relative risk cannot be established through

this design. Thirdly, it was not possible to perform analysis of differences between respondents and nonrespondents. A possible selection bias is that the prevalence of injuries and musculoskeletal pain might have been higher among the respondents compared to the nonrespondents, thus affecting the results and the external validity of the study. Finally, the self-reporting of injuries and musculoskeletal pain is also a limitation, since this method makes it impossible to verify the injury location and type by a third party. However, the assessment of physical fitness of FI and SI as well as daily workload and their perceived exertion are valuable information to focus on and when designing future studies. We therefore suggest that future research considers these factors to conduct more meaningful longitudinal studies on this topic.

CONCLUSION

In conclusion, a high 2-year prevalence of instruction-related musculoskeletal disorders and vocal pathologies was observed in FI and SI, respectively. The role of the work environment should be considered as an occupational hazard. Guidelines on the maximum weekly instruction load are therefore recommended for SI and FI professionals.

DATA AVAILABILITY STATEMENT

The data supporting the conclusions of this article will be made available by the authors, upon request, without undue reservation.

ETHICS STATEMENT

The studies were reviewed and approved by Scientific and Technical Committee of the ISPESL (Istituto Superiore Prevenzione e Sicurezza sul Lavoro, Italian Ministry of Health, n° B19/DOC/03). The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MAM designed the study (with Prof. Arsenio Veicsteinas) and performed the data collection. MB, LA, GM, and SM analyzed the data, provided the figures, and together with DG wrote up the manuscript. MAM, H-CG, and GM did the critical revision of the manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.666019/full#supplementary-material

REFERENCES

1. Deloitte and EuropeActive. *European Fitness Market Continues to Grow.* (2019). Available online at: https://www2.deloitte.com/content/dam/Deloitte/es/Documents/acerca-de-deloitte/Deloitte-ES-TMT-European-Health-Fitness-Market-2019.pdf
2. Garrick JG, Gillien DM, Whiteside P. The epidemiology of aerobic dance injuries. *Am J Sports Med.* (1986) 14:67–72. doi: 10.1177/036354658601400111
3. Rothenberger LA, Chang JI, Cable TA. Prevalence and types of injuries in aerobic dancers. *Am J Sports Med.* (1988) 16:403–7. doi: 10.1177/036354658801600417
4. du Toit V, Smith R. Survey of the effects of aerobic dance on the lower extremity in aerobic instructors. *J Am Podiatr Med Assoc.* (2001) 91:528–32. doi: 10.7547/87507315-91-10-528
5. Romaine LJ, Davis SE, Casebolt K, Harrison KA. Incidence of injury in kickboxing participation. *J strength Cond Res.* (2003) 17:580–6. doi: 10.1519/00124278-200308000-00026
6. Malliou P, Rokka S, Beneka A, Gioftsidou A, Mavromoustakos S, Godolias G. Analysis of the chronic lower limb injuries occurrence in step aerobic instructors in relation to their working step class profile: a three year longitudinal prospective study. *J Back Musculoskelet Rehabil.* (2014) 27:361–70. doi: 10.3233/BMR-140456
7. Bratland-Sanda S, Sundgot-Borgen J, Myklebust G. Injuries and musculoskeletal pain among norwegian group fitness instructors. *Eur J Sport Sci.* (2015) 15:784–92. doi: 10.1080/17461391.2015.1062564
8. Heidel SE, Torgerson JK. Vocal problems among aerobic instructors and aerobic participants. *J Commun Disord.* (1993) 26:179–91. doi: 10.1016/0021-9924(93)90007-W
9. Rumbach AF. Voice problems of group fitness instructors: diagnosis, treatment, perceived and experienced attitudes and expectations of the industry. *J Voice.* (2013) 27:786.e1–9. doi: 10.1016/j.jvoice.2013.03.012
10. Estes C, Sadoughi B, Coleman R, D'Angelo D, Sulica L. Phonotraumatic injury in fitness instructors: risk factors, diagnoses, and treatment methods. *J Voice.* (2020) 34:272–9. doi: 10.1016/j.jvoice.2018.10.001
11. Gauvin N, Fleury A, Reynolds V. Vocal health of sporting, fitness, and wellness leaders in northern New York and vermont. *Logop Phoniatr Vocol.* (2021) 1–7. doi: 10.1080/14015439.2021.1897671
12. Long J, Williford HN, Olson MS, Wolfe V. Voice problems and risk factors among aerobics instructors. *J Voice.* (1998) 12:197–207. doi: 10.1016/S0892-1997(98)80039-8
13. Fontan L, Fraval M, Michon A, Déjean S, Welby-Gieusse M. Vocal problems in sports and fitness instructors: a study of prevalence, risk factors, and need for prevention in france. *J Voice.* (2017) 31:261.e33–261.e38. doi: 10.1016/j.jvoice.2016.04.014

14. Artino AR, Durning SJ, Sklar DP. Guidelines for reporting survey-based research submitted to academic medicine. *Acad Med.* (2018) 93:337–40. doi: 10.1097/ACM.0000000000002094
15. Fuller CW, Ekstrand J, Junge A, Andersen TE, Bahr R, Dvorak J, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Br J Sports Med.* (2006) 40:193–201. doi: 10.1136/bjsm.2005.025270
16. Howley ET, Bassett DR, Welch HG. Criteria for maximal oxygen uptake: review and commentary. *Med Sci Sports Exerc.* (1995) 27:1292–301. doi: 10.1249/00005768-199509000-00009
17. Sohl P, Bowling A. Injuries to dancers. Prevalence, treatment and prevention. *Sports Med.* (1990) 9:317–22. doi: 10.2165/00007256-199009050-00006
18. Borg E, Borg G. A comparison of AME and CR100 for scaling perceived exertion. *Acta Psychol.* (2002) 109:157–75. doi: 10.1016/S0001-6918(01)00055-5
19. Hickey M, Hager CA. Aerobic dance injuries. *Orthop Nurs.* (1994) 13:9–12. doi: 10.1097/00006416-199409000-00003
20. Scharff-Olson M, Williford HN, Blessing DL, Brown JA. The physiological effects of bench/step exercise. *Sports Med.* (1996) 21:164–75. doi: 10.2165/00007256-199621030-00002
21. Williams N, Carding P (editors). *Occupational Voice Loss*. 1st ed. CRC Press (2005). doi: 10.1201/b1413
22. Ruotsalainen J, Sellman J, Lehto L, Verbeek J. Systematic review of the treatment of functional dysphonia and prevention of voice disorders. *Otolaryngol Head Neck Surg.* (2008) 138:557–65. doi: 10.1016/j.otohns.2008.01.014
23. Nieman DC. Is infection risk linked to exercise workload? *Med Sci Sports Exerc.* (2000) 32:S406–11. doi: 10.1097/00005768-200007001-00005
24. Ruotsalainen JH, Sellman J, Lehto L, Jauhiainen M, Verbeek JH. Interventions for preventing voice disorders in adults. *Cochrane database Syst Rev.* (2007) *CD*006372. doi: 10.1002/14651858.CD006372.pub2
25. Thickett KM, McCoach JS, Gerber JM, Sadhra S, Burge PS. Occupational asthma caused by chloramines in indoor swimming-pool air. *Eur Respir J.* (2002) 19:827–32. doi: 10.1183/09031936.02.00232802
26. Conklin RJ. Common cutaneous disorders in athletes. *Sport Med.* (1990) 9:100–19. doi: 10.2165/00007256-199009020-00004
27. Wanke EM, Schmidt M, Oremek G, Groneberg DA. Work related cardiovascular load in professional dance teachers – a pilot study. *J Occup Med Toxicol.* (2020) 15:7. doi: 10.1186/s12995-020-00257-0

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Evaluation of Sensitization Program on Occupational Health Hazards for Nursing and Allied Health Care Workers in a Tertiary Health Care Setting

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Background: Occupational health hazard pertaining to health care providers is one of the neglected areas that need serious attention. Any compromise in their safety would result in reduction in workforce, which may affect patient care, keeping in mind the wide gap between the required number and actual health care workers (HCWs) available in the world over.

Aim: This study was undertaken to evaluate the change in knowledge through a sensitization training program on occupational health hazards and vaccination for HCWs.

Materials and Methods: Participants of the study included nursing and allied HCWs of a tertiary care health institute in Uttarakhand, India. Multiple training sessions, each of around 180 min, were held periodically in small groups with 20–40 participants over 2 years. Participants were assessed with pretest and posttest questionnaires, and feedback was taken. Questionnaires comprised three categories: general safety and ergonomics, biological hazards, and chemical and radiation hazards. Data of incident reporting for needlestick injury from 2017 to 2019 were retrieved. All data were compiled in Excel sheet and analyzed.

Results: A total of 352 participants were included in the study. Mean ± SD for pretest and posttest scores were 5.3 ± 2.13 and 11.22 ± 2.15, respectively. There was considerable improvement in knowledge, which was found to be statistically significant with p-value of 0.001 for all categories. Participants in their feedback suggested for inclusion of psychosocial aspect in further training programs.

Conclusion: Low baseline knowledge prior to attending the course highlights a need for an intervention through such structured sensitization program to create awareness and educate HCWs on common occupational health hazards and vaccination. Statistically significant improvement in posttest knowledge highlights effectiveness of the training program. A drastic rise in incident reporting for needlestick injury reflects fairly good

impact of training program. Regular and appropriate form of training can reduce injuries resulting from occupational hazards and ensure healthy workforce contributing toward a positive impact on national economy.

Keywords: continuous professional development (CPD), effectiveness, healthcare workers (HCW), occupational health hazards, sensitization, training, vaccination

INTRODUCTION

The World Health Organization (WHO) has described occupational health as development, promotion, protection, enhancement, and enabling of all aspects, i.e., physical, mental, and social health of workers (1). All work environments, including the health care sector, pose various hazards for the workers. Health care workers (HCWs) include professional medical workers such as doctors, nurses, and all paramedical workers, assistants, students, or trainees and general staff. WHO has described various occupational hazards in the workplace such as air contaminants, chemical hazards, radiation hazards, biological hazards, physical hazards such as noise and heat, ergonomic hazards, and psychosocial hazards (1).

There are many resources available to develop programs for addressing occupational health hazards, and every organization may design its own program as per availability of professionals and other resources. However, sensitization of all involved personnel is the first step toward a healthy work environment. One of the primary reasons for occupational injuries in HCWs is not being aware of the hazards that they are exposed to in their workplace. Inadequacy of knowledge or non-adherence to the safety preventive measures leads to chronic illnesses, functional impairment, disabilities, and even sometimes death, which affects the individual's family, institute, and manpower resource of the country. An assessment of baseline knowledge of HCWs will be useful to determine their existing understanding so that interventions can be planned through focused training programs for their enlightenment and update (2). Regular appropriate training can reduce injuries resulting from occupational hazards, which in turn may have a positive impact on national economy especially in developing or low-income countries (3).

AIM

This study was undertaken to assess the baseline knowledge of HCWs and the immediate effect of sensitization training program on occupational hazards through objective assessment.

MATERIALS AND METHODS

This was a study done at a tertiary care medical institute in Uttarakhand, India, which included data from 2018–2020. Participants of this study included nursing and allied HCWs (technicians). A structured training module on occupational hazards was designed for sensitizing and educating the participants. Basic information about vaccination for HCWs was also covered as a component of protection from biological hazards. This initiative was a part of the various regular training programs scheduled for continuous professional development program. The training workshop comprised an interactive session of 3-h duration, which included general protocols, biological, chemical, radiation, and ergonomic health hazards. Session submodules consisted of short lectures using PowerPoint presentation with case scenarios followed by interactive discussion. One session each was conducted on general protocols of safety in hospital sector and biological hazards and vaccination of 30-min duration, followed by chemical hazards for 30 min, ergonomic hazards for 15 min (**Figure 1**), and radiation safety 20 min. Social and psychosocial factors were not included in our program. Relevant resource materials from standard guidelines, such as WHO, Centers for Disease Control and Prevention (CDC), the Occupational Safety and Health Act of 1970 (OSH Act), and Atomic Energy Regulatory Board (AERB), were utilized (1, 4–6). The sessions were conducted in small groups with maximum 40 participants. Nursing and allied HCWs participated in the training. Evaluation of the effect of intervention was done using objective assessment (posttest) through the same set of questionnaires as used in the pretest. The pretest was conducted to assess the baseline knowledge of participants with multiple-choice questions prior to starting the training program. The questionnaire consisted of 15 questions within three categories, i.e., general safety and ergonomics (six questions), biological hazards (four questions), and chemical and radiation hazards (five questions). All questionnaires were evaluated for response. Each category was analyzed separately, and results were assessed; i.e., mean, standard deviation, and test of significance were applied using SPSS software version

FIGURE 1 | Participants performing exercise while being demonstrated by an instructor during delivery of ergonomic training module.

TABLE 1 | Category-wise pretest and posttest scores and total scores ($n = 351$).

Category	% Score in pretest	% Score in posttest	Difference in pretest vs. posttest	*p*-value
General safety and ergonomics	47	88	41%	0.001
Biological hazards	27	75	48%	0.001
Chemical and radiation hazards	39	74	35%	0.001

23. Feedback was taken from participants with close-ended and open-ended questions and was further analyzed. On completion of the training program with a score of 80% and greater, certificates were distributed to participants. Resource faculty were also provided with appreciation certificate.

Data of needlestick injury (NSI) including blood and body exposure reported by HCWs at the institute was collected and analysed.

RESULTS

A total of 351 participants were trained over 12 sessions, which included 324 nursing officers of different cadres, and 27 laboratory technicians. Participants were predominantly females (254; 72.4%), and the rest were males (97; 27.6%). Pretest and posttest performances were analyzed with mean ± SD pretest and posttest scores of 5.3 ± 2.13 and 11.22 ± 2.15, respectively. Statistically significant improvement in knowledge was noted in posttest for all submodules (**Table 1**). Maximum improvement in knowledge was noted for a session on biological hazards (**Table 1**).

Feedback on Training Module

On analysis of participants' perception about workshop and key learning points learned, it was revealed that all participants felt time accorded to training was adequate (100%). The content of program was excellent (50.8%) to good (48.2%) for the majority, whereas delivery of content was equally excellent (45.6%) to good (52.4%). Method used for training was considered appropriate (100%). All participants (100%) responded that there was skill enhancement after training and considered training content very useful. Participants responded that biological hazards and vaccination submodules were highly useful (**Figure 2**). Participants recommended few suggestions for future training workshops (**Table 2**).

A considerable increase in reporting of NSI including blood and body exposure cases was noted (**Table 3**).

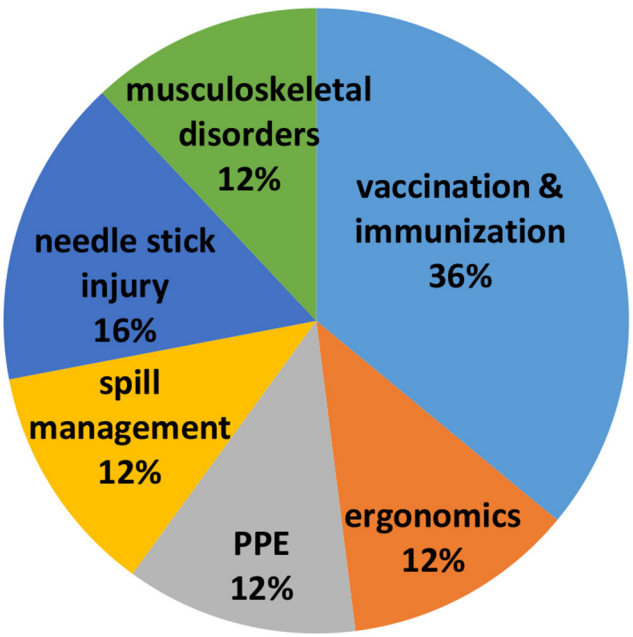

FIGURE 2 | Usefulness of content as per participants' feedback.

DISCUSSION

The health care sector is a field for improving the health of others; however, ironically, it possesses every kind of health hazards and has been found to have a higher-than-average rates of occupational health hazards (7). While the HCWs focus on providing patient care, they become exposed to many occupational hazards that could affect their health and well-being (8). The most common occupational hazards found in the health care setting are chemical, biological, physical, and psychosocial hazards; however, many workers are unaware of the hazards they are exposed to, and this may prove to be injurious for themselves and their colleagues, as well as the patients (9–11).

The hazards for medical professionals have been defined broadly in older documents; however, currently, agencies such as the CDC, the National Institute for Occupational Safety and Health, and the Occupational Safety and Health Administration (OSHA) provide guidelines and standards for information and prevention on occupational hazards for all including medical workers (4–6, 12). These are acceptable as standard guidelines in world over for practical purpose. Often, HCWs, especially in the developing world, are aware of the hazards but may be unable to help themselves from their risks due to knowledge about the same or lack of resources (8). A study conducted by Aluko et al. (8) highlighted that HCWs hardly practiced safety measures at the workplace despite having a good level of knowledge about the preventive means for occupational hazards.

A review published by Rai et al. (13) documents that practice of occupational hazard risk reduction strategies is deficient. Rai et al. documented that most of the studies are focused on biological hazards, whereas, research studies on other hazards were limited in comparison. Our training program comprehensively covered general policies and measures, biological, chemical,

TABLE 2 | Feedback of participants.

Sessions that need more elaboration	Any other topics that can be included in this workshop	Take-home messages (as per participants)
Biological hazards, 35% Chemical hazards, 30% Psychosocial hazards, 22% Vaccination, 5% Immunization, 5% Spill management, 3% Safe disposal and handling of cytotoxic drugs, 5%	• Respiratory safety • Ergonomic specific to nursing • Brachytherapy • Water hygiene, food hygiene, nutrition	• Prevent musculoskeletal disease with appropriate posture • Get vaccinated as soon as possible • Self-protection methods • Prevention is better than cure • Minimize radiation exposure • Follow proper use of personnel protective equipment and their disposal, prevention from needlestick injury • Occupational hazards can be prevented to great extent by proper training and management • Follow ergonomics—maintain good body (posture to avoid future disability)

TABLE 3 | Needlestick injury including blood and body exposure cases reported at the institute from 2017 to 2019.

Time frame	Total cases reported	Among nursing officers
2017 (From September to December)	10	2
2018 (From January to December)	91	45
2019 (From January to September)	99	42

musculoskeletal, and radiation occupational hazards and its preventive measures.

It is a well-known fact that there is a vast deficiency of HCWs all over the world. Most of escalated health care costs are attributed to newer equipment and drugs while escalation of expenses on nursing, or manpower development and maintenance are negligible. These have led to poorer patient care outcomes. These have also led to negative outcomes among nursing and other HCWs such as higher absenteeism or earlier retirement. Issues such as musculoskeletal disorders, stress, or dermatological issues and many more directly or indirectly associated with their occupation are responsible for this situation even in the developed countries (14). Therefore, to safeguard the health of HCWs in low- to middle-income countries, authorities should consider and prioritize this as one of the public health issues. Focused research to assess knowledge on occupational hazards will give an insight into lacunae and gap in knowledge of HCWs.

It has been noted that in comparison to other workers, such as miners, the occupational health of HCWs fades in the background as they are at the helm of caring for the vulnerable sick and injured. Partial knowledge may be dangerous, especially in the health care sector where HCWs are at the interface of disease and health of the people. Although, HCWs have better knowledge about occupational hazards compared to the other sectors such as sawmill workers, farmers, or miners, more than a third of HCWs failed to recognize work-related health hazards (8, 15).

NSIs are the commonest accidents among HCWs followed by direct contact with blood, chemical burns, and floor injuries such as slipping. In our program, the session on biological hazards and vaccination was scored as the most useful as per participant feedback. Our study also showed a positive trend in reporting of NSI, which reflects definite impact of the training program in this group of HCWs. Abuduxike et al. in their study on HCWs evaluated experience of NSIs and factors related to it through self-administered questionnaire and found low adherence to standard precautions. They further suggested such behavior and practice can be changed through a regular, focused training program based on occupational risk, and exposure (16).

The major hazardous activities in a health care setting have been known to be injection, cleaning, patient care, bedding, dressing of wounds, medication, and surgical operation; all of these activities involve biological hazard exposure (17). This could be attributed to the fact that despite their primary training in handling infectious materials, there are maximum reported incidents of direct skin contact with infectious materials and NSIs among HCWs. This is an indicator of training reinforcement to bring about behavioral changes among HCWs and improved practices (18).

There are not many published reports pertaining to occupational health care among the HCWs from the Indian subcontinent. Thus, it may be assumed that not many institutions/health care facilities are performing such a program in this setting (19). The Advanced Center of Continuous Professional Development at our institute took over this task and developed this program for initiating health promotion. Training modules were developed by the resource persons who were specialized in the respective areas of the module allotted to them. There were four modules in each session, including major occupational hazards such as general policies and protocols, biological (bloodborne pathogens, tuberculosis), ergonomic (musculoskeletal problems), and radiation hazards and chemical hazards (toxic chemicals in the laboratory, latex allergy, and chemotherapeutic drugs). The participants responded in their feedback that they were highly satisfied by the training module. As per the OSHA guidelines, organizations must involve workers in the program and accommodate training and all actions pertaining to occupational safety within working hours. We complied with these guidelines in our study (5). Specialized occupational health professionals usually address these issues; however, these trained professionals may not be available everywhere even in the developed countries and even if they may not able to cater to the vast number of health care professionals (1). In such situations, HCWs may themselves take up the additional responsibility of health promotion at the workplace.

There was a statistically significant improvement in pretest and posttest scores among all participants for the workshop. Sensitization to the various aspects of occupational hazards was thus achieved in our workshop. The salient feature of the present

study was evidence-based information on baseline knowledge of HCWs on workplace health hazards and preventive/safety measures. The study reveals necessity to develop and implement strategies including focused training to improve the knowledge, practice, and compliance of preventive measures against occupational health hazards (16). One of the factors for success is the number of participants in the program. Our sessions were limited to <40 participants. This has been shown to be an important factor as larger-sized batches (60–80) have shown to have an adverse effect on training/interaction in other studies (19). This program is an ongoing continuous feature in our institution, and it is ensured that every nursing staff/student and paramedical worker is mandatorily trained/sensitized.

Analysis of feedback from participants in our training revealed that time accorded to training was adequate, content and delivery of content were found to be acceptable, and they felt that the session was useful for them. The participants recommended including a session on stress and psychosocial hazards, which was lacking in our training module. Myths or fears can cause wrong practices/avoidance of certain work practices; on the other hand, overconfidence due to ignorance may lead to unnecessary injury or exposure to hazards. It has also been seen in the past that HCWs are aware of their lack of knowledge and information about occupational hazards and realize the need for training and awareness (20).

Stress and psychosocial hazards are pertinent problems in any health care setting. Rosenberg et al. conducted a questionnaire-based study on Finnish anesthetists and found that a higher number of abortions were noted among anesthetists, as compared to incidence before entering anesthetic work. The possible reasons as put forward by them included anesthetic gases, smoking, and psychosocial hazard (21). Their study also revealed that gestation time for full-term pregnancies and miscarriages was shorter in the anesthetist group as compared to the pediatrician group (21). Regular appropriate training can reduce injuries resulting from occupational hazards, which in turn may have a positive impact on national economy (2).

Routine training and reinforcement programs based on accepted guidelines on safety practices through mock drills in all health facility centers should be made mandatory (22). Sessions resource could be posted online for web-based learning, and this mode may prove effective for delivery of knowledge as noted in a study conducted by Tung et al. (23). A recent observational study by Cattelan et al. documented the positive impact of an effective training program in preventing infection with severe acute respiratory syndrome coronavirus 2 infection in HCWs. This reiterates the role of quality training program for preventing biological hazard from acquiring highly infectious disease (24).

Positive reinforcement of employees can be performed by the ways of incentives or recognition. Certificates of participation were awarded to all the participants, and certificates to resource faculty as well in our program.

LIMITATIONS

It has been seen that psychosocial factors and various other stressors have an impact on HCWs, especially nurses (25). We did not cover psychosocial hazards; however, it will be included in future sessions. There is a need to include assessment of active reporting about safety and health concerns by employees; however, this record was not available for analysis.

CONCLUSION

To, the best of our knowledge, this is one of the first documented studies in India, where basic comprehensive sensitization training program on occupational health hazard training has been performed and evaluated. Low baseline knowledge prior to attending the course, highlights a need for an intervention through such structured sensitization program to create awareness and educate HCWs on common occupational health hazards and vaccination. Statistically significant improvement in posttest knowledge highlights the effectiveness of the training program. Regular and appropriate training can reduce injuries resulting from occupational hazards and ensure healthy workforce contributing toward a positive impact on national economy.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by AIIMS/IEC/2020/788-dated 21/11/2020.

AUTHOR CONTRIBUTIONS

MN, VD, and SR: conceptualization and manuscript preparation and writing. MK and PG: assistance in data collection. RK: statistical analysis. SR: overall supervision, data collection, and editing manuscript. All authors contributed to the final article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.669179/full#supplementary-material

REFERENCES

1. World Health Organization. *Occupational Health: A Manual for Primary Health Care Workers*. (2021). Available online at: https://www.who.int/occupational_health/publications/emhealthcarework/en/ (accessed April 5, 2021).
2. Obono M, Adeosun SA, Olaiya PA, Adesina A. Assessment of the knowledge, attitudes and perception of Potential Occupational Hazards by Healthcare Workers in a Tertiary Healthcare Facility in Lagos, Nigeria. *Int J Res Sci Innov*. (2019) 6.
3. Paganelli M, Madeo E, Nabeel I, Pilia I, Lecca LI, Pili S, et al. Education and training in global occupational health and safety: a perspective on new pathways to sustainable development. *Ann Glob Health.* (2018) 84:538–40. doi: 10.29024/aogh.2309
4. CDC. Immunization of health-care personnel recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR*. (2011) 60:1–45. Available online at: https://www.cdc.gov/mmwr/preview/mmwrhtml/00050577.htm
5. Occupational Safety and Health Administration. *What's New - 2021*. (2021). Available at: www.osha.gov 2021; https://www.osha.gov/sites/default/files/publications/OSHA3885.pdf (accessed May 12, 2021).
6. AERB. *Radiation Protection Principle*. Aerb.gov.in (2021). Available online at: https://www.aerb.gov.in/english/radiation-protection-principle (accessed April 5, 2021).
7. McDiarmid MA. Chemical hazards in health care: high hazard, high risk, but low protection. *Ann N Y Acad Sci.* (2006) 1076:601–6. doi: 10.1196/annals.1371.032
8. Aluko OO, Adebayo AE, Adebisi TF, Ewegbemi MK, Abidoye AT, Popoola BF. Knowledge, attitudes and perceptions of occupational hazards and safety practices in Nigerian healthcare workers. *BMC Res Notes.* (2016) 9:71. doi: 10.1186/s13104-016-1880-2
9. Ziaferi SG, Sourtzi P, Kalokairinou A, Sgourou E, Koumoulas E, Velonakis E. Risk assessment of physical hazards in greek hospitals combining staff's perception, experts' evaluation and objective measurements. *Saf Health Work J.* (2011) 2:260–72. doi: 10.5491/SHAW.2011.2.3.260
10. National Population Commission. *2006 Population and Housing Census of the Federal Republic of Nigeria*. Lagos: Osun State Priority Tabes National Population Commission (2009). vol. 1, p. 33.
11. Ndejjo R, Musinguzi G, Yu X, Buregyeya E, Musoke D, Wang JS, et al. Occupational health hazards among healthcare workers in Kampala, Uganda. *J Environ Public Health.* (2015) 2015:913741. doi: 10.1155/2015/913741
12. Moore RM Jr, Kaczmarek RG. Occupational hazards to health care workers: diverse, ill-defined, and not fully appreciated. *Am J Infect Control.* (1990) 18:316–27. doi: 10.1016/0196-6553(90)90231-G
13. Rai R, El-Zaemey S, Dorji N, Fritschi L. Reliability and validity of an adapted questionnaire assessing occupational exposures to hazardous chemicals among health care workers in Bhutan. *Int J Occup Environ Med.* (2020) 11:128–39. doi: 10.34172/ijoem.2020.1878
14. Froneberg B. National and international response to occupational hazards in the healthcare sector. *Ann N Y Acad Sci.* (2006) 1076:607–14. doi: 10.1196/annals.1371.022
15. Agbana BE, Joshua AO, Daikwo MA, Metiboba LO. Knowledge of occupational hazards among sawmill workers in Kwara state, Nigeria. *Niger Postgrad Med J.* (2016) 23:25–32. doi: 10.4103/1117-1936.180176
16. Abuduxike G, Acar Vaizoglu S, Asut O, Cali S. An assessment of the knowledge, attitude, and practice toward standard precautions among health workers from a hospital in northern cyprus. *Saf Health Work.* (2021) 12:66–73. doi: 10.1016/j.shaw.2020.09.003
17. Manyele SV, Ngonyani HA, Eliakimu E. The status of occupational safety among health service providers in hospitals in Tanzania. *Tanzan J Health Res.* (2008) 10:159–65. doi: 10.4314/thrb.v10i3.14356
18. Senthil A, Anandh B, Jayachandran P, Thangavel G, Josephin D, Yamini R, et al. Perception and prevalence of work-related health hazards among health care workers in public health facilities in southern India. *Int J Occup Environ Health.* (2015) 21:74–81. doi: 10.1179/2049396714Y.0000000096
19. Viramgami AP, Sadhu HG. Evaluation of training program "Basic Concepts of Occupational Health" for students of diploma in sanitary inspector course and way forward. *Indian J Occup Environ Med.* (2018) 22:106–8. doi: 10.4103/ijoem.IJOEM_79_18
20. El-Sallamy RM, Kabbash IA, El-Fatah SA, El-Feky A. Physical hazard safety awareness among healthcare workers in Tanta university hospitals, Egypt. *Environ Sci Pollut Res Int.* (2018) 25:30826–38. doi: 10.1007/s11356-017-9110-6
21. Rosenberg PH, Vänttinen H. Occupational hazards to reproduction and health in anaesthetists and paediatricians. *Acta Anaesthesol Scand.* (1978) 22:202–7. doi: 10.1111/aas.1978.22.3.202
22. Ford MT, Tetrick LE. Relations among occupational hazards, attitudes, and safety performance. *J Occup Health Psychol.* (2011) 16:48–66. doi: 10.1037/a0021296
23. Tung CY, Chang CC, Ming JL, Chao KP. Occupational hazards education for nursing staff through web-based learning. *Int J Environ Res Public Health.* (2014) 11:13035–46. doi: 10.3390/ijerph111213035
24. Cattelan AM, Sasset L, Di Meco E, Cocchio S, Barbaro F, Cavinato S, et al. An integrated strategy for the prevention of SARS-CoV-2 infection in healthcare workers: a prospective observational study. *Int J Environ Res Public Health.* (2020) 17:5785. doi: 10.3390/ijerph17165785
25. Kowalczuk K, Krajewska-Kułak E, Sobolewski M. Factors determining work arduousness levels among nurses: using the example of surgical medical treatment and emergency wards. *Biomed Res Int.* (2019) 2019:6303474. doi: 10.1155/2019/6303474

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Blood Pressure Changes After a Health Promotion Program Among Mexican Workers

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Background: Cardiovascular disease is becoming increasingly prevalent in low and middle-income countries (LMIC), and high blood pressure (BP) is one of the main risk factors. The efficacy and sustainability of worksite health promotion (WHP) programs for BP reduction in LMIC have yet to be determined.

Methods: This non-randomized company-based trial evaluated 6- and 12-months effects of a WHP intervention on BP among 2,002 participating workers from seven Mexican companies. Intervention and control groups were assigned at the company level. The intervention included nutrition counseling, physical exercise, and stress management components. Mixed models assessed differences in BP change between intervention and control companies in intent-to-treat (ITT), per-protocol (PerP), and as-treated (AsTr) analyses, and also within-group changes stratified by company, intervention component, and baseline cardiovascular risk factor levels. All analyses were adjusted for potential confounders. We accounted for missing data and loss to follow-up using inverse probability of censoring weighting.

Results: ITT analyses revealed mean BP change differences of −1.1 mmHg at 12 months (95% CI: −2.9; 0.6) in intervention companies relative to control companies. PerP and AsTr analyses confirmed this finding. Within-group analyses showed consistent BP reductions at both 6 and 12 months. Substantial differences in BP changes ranging from diastolic −6.1 mmHg, (95% CI: −11.2; −1.2) to systolic −13.0 mmHg (95% CI: −16.0; −10.1) were found among individuals with diabetes at baseline in intervention companies relative to control companies.

Conclusion: After 1 year, WHP was associated with modest but uncertain BP reductions. Substantial reductions were mainly observed among diabetic workers.

Keywords: cardiovascular risk factors, intervention study, workplace, health promotion, blood pressure, diabetes mellitus, Mexico, multilevel analysis

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INTRODUCTION

Each year, 2.3 million work-related deaths occur worldwide, of which two million are attributable to occupational diseases. Work-related circulatory diseases, including hypertension, are becoming more prevalent in low and middle-income countries (1) and are responsible for 23% of annual work-related deaths globally ranking second after occupational cancer (2).

In Mexico, the top five causes of death in 2017 were all non-communicable diseases, of which circulatory diseases were the greatest contributor (3). High blood pressure (BP) is one of the main risk factors for circulatory diseases, affecting both men and women and contributing to up to 10% of disability adjusted live years lost (3). The costs and financial consequences attributable to hypertension alone increased up to 32% from 2013 to 2018 in several states of Mexico (4), and a recent study indicated that should the prevalence of hypertension in this country remain the same, the number of adults in need of hypertension care will increase 151% by 2050 (5).

Worksite health promotion (WHP) has been identified as advantageous for the management and prevention of non-communicable diseases because work is the place where people spend most of their waking hours and it offers an ideal infrastructure to reach large and captive audiences while eliminating some of the barriers to engage in health promotion activities, such as insufficient time, lack of social support, and limited financial resources (6, 7). Additionally, many benefits have been identified with workplace interventions both at the organizational (reduced absenteeism and health-care costs, increased productivity) and individual (improved morale, increased job satisfaction and health) level (8, 9).

Unfortunately, very few studies reporting the efficacy of workplace interventions come from low and middle-income countries, including Mexico (10). An online search on PubMed, Elsevier, and SciELO using the terms "worksite," "workplace," "wellness," "health promotion," "interventions," AND "Mexico" yielded only four longitudinal studies (10–13). These studies had major limitations, including small sample size of self-selected volunteers, lack of a control group, and failure to account for potential confounders or loss to follow-up, and consequently cannot provide reliable evidence for the efficacy of WHP programs in Mexico.

Methodological deficiencies were also noted for studies from high-income countries. A meta-analysis including reviews from the USA, Australia, Canada, Japan, and Europe described available research as being of "suboptimal quality" and inadequate for evaluating sustainability or long-term efficacy (14). A systematic review of wellness programs and their health-related outcomes similarly reported low quality of publications; i.e., no randomized trials or systematic reviews. Only three of the 20 evaluated studies were peer-reviewed, and only one article disclosed a control group to compare intervention participants at the same company (15).

Mexico seeks to meet workers' health needs through social security institutions. The Mexican Institute of Social Security (*Instituto Mexicano del Seguro Social,* IMSS) is responsible for providing universal health insurance to workers in the private sector and their families and is considered the largest social security institution in the country (16).

Aiming to overcome the limitations in research stated above, we evaluated the effects of an IMSS-sponsored multi-component, six-month intervention program on several cardiovascular disease (CVD) risk factors such as BP, body mass index, blood glucose, cholesterol and triglycerides, among employees of diverse companies affiliated with IMSS in Mexico City. This study only reports the effects of the intervention on BP using a control group, long-term follow-up data, and adequate analytic strategies to minimize the threat of bias due to selection and confounding.

MATERIALS AND METHODS

Study Design and Study Population

This prospective, quasi-experimental study consisted of a six-month company-based WHP intervention trial with a 6- and 12-month follow-up after the start of the intervention. IMSS' researchers promoted participation in this study among affiliated companies located in Mexico City and recruited 2,002 workers from seven different worksites, including a cooking utensils factory, a government public health services department, a metalworking company, a pharmaceutical company, a plastic factory, and a printing company. Companies were selected on the basis of their willingness to engage in the study's activities and consented to be part of either a control ($n = 991$) or an intervention group ($n = 1{,}011$). Employers were presented with the intervention first and if they did not agree to participate, the option to enter the study as a control company was offered second.

Recruitment of Workers

IMSS researchers met with the directors of each company to introduce the intervention program and obtain authorization to perform the activities. Nurses and social workers from the research team promoted the intervention throughout the company. As an incentive, they offered workers a complete and confidential physical examination, including blood tests such as glucose, cholesterol, and triglyceride levels for free. They remained in each of the companies for about a week to enroll as many participants as possible but no further efforts were made to reach workers on sick leave or disability. All participants provided written, informed consent before the onset of the study.

Assessment of Baseline Health Status

Individual CVD risk factors were assessed via questionnaires, physical exams, and serologic tests. IMSS experts including occupational physicians, nurses, psychologists, nutritionists, and sports medicine specialists designed a health risk assessment questionnaire assessing socio-demographic and organizational characteristics, behavioral and biological risk factors for CVD, and personal history of diabetes, hypertension, CVD, and other self-reported doctors' diagnoses. The questionnaire was distributed among participants who completed it at home and submitted it to the research team on the day of their physical evaluation.

The physical examination included anthropometric (height, weight, waist circumference, and skinfold measurements to assess body fat, muscle, and bone mass), physiological measurements (heart rate, BP, maximum oxygen intake), and a finger-stick cholesterol and glucose screening (see **Supplementary Appendix 1**). Assessors were not blind to intervention allocation. Detailed descriptions of these assessments were published previously (17).

Intervention Program

The WHP program lasted 6 months and included the following components: nutrition counseling, physical activity, and stress management. After initial screening for CVD risk factors through the health risk assessment survey, workers were invited to attend one or more intervention groups according to their specific individual health needs. Participation was voluntary. Prevention activities were offered both at the group and individual level during paid work hours.

Nutrition Component

As a first step, workers were invited to participate in one of several offered 30-min information sessions (for maximal 25 participants each) to discuss the basic food groups. Next, two 30-min meetings were held to teach workers how to record their daily food intake and to develop a diet plan according to the workers' preferences and individual needs identified by a licensed and certified nutritionist (**Supplementary Appendix 2**).

A number of 30 minute individual follow-up sessions were offered based on the World Health Organization classification for body mass index (18): Weekly for obesity class III (BMI $\geq$ 40), bi-weekly for obesity classes II (BMI 35.0–39.9) and I (BMI 30.0–34.9), monthly for overweight (BMI 25.0–29.9) and underweight (BMI<18.5), and every 2 months for normal weight (BMI 18.5–24.9).

A nutritional history was documented and each worker's diet plan was discussed. Each worker set personal goals and received recommendations to maintain a healthy and balanced diet based on the official Mexican standard 043 (NOM-043-SSA2-2005) and the Eatwell Guide (*Plato del Bien Comer)* (19).

Physical Activity Component

Thirty-minute physical exercise sessions were offered daily during the work shift for 24 weeks and were led by a certified group fitness instructor. Each session included warm-up (5 min), aerobics (20 min), and muscle strengthening and stretching (5 min). Workers' workouts were individualized depending on their current physical activity level (determined through the health risk assessment questionnaire) and cardiorespiratory fitness (determined via step test, see **Supplementary Appendix 1**). Exercise sessions were geared to achieve conditioning responses and optimal benefit according to guidelines from the American College of Sports Medicine (20). Specifically, exercises for sedentary workers (those who did not exercise regularly both at work and off-work) were designed to reach 60% of their maximum heart rate while exercises for active workers (those engaging in regular exercise at least three times per week) were designed to reach 65% of their maximum heart rate. The intensity of exercise was increased by 5% every 4 weeks until participants reached 80% of their maximum heart rate.

Stress Management Intervention Component

Weekly sessions of 30 min each, led by a licensed social worker, were offered for groups of 10 to 15 participants on a first-come, first-served basis. These sessions were designed according to secondary prevention stress management programs aiming at the individual with the goal to reduce the severity of stress symptoms before they lead to serious health problems (21). The stress management intervention comprised three different steps, including stress definition and establishment of personal commitments (step 1); redefinition of stress and teaching of stress management techniques (step 2); and follow-up and discussion on how to apply stress management techniques (step 3).

Health Outcome: Change in BP

At baseline and 6- and 12-month follow-up examinations, BP was measured manually by two research nurses using a sphygmomanometer and following protocols from the American Heart Association (22). Workers rested for about 5 min before the measurement, which was taken on their left arm while sitting. However, only one reading was taken due to time constraints, instead of the two or more consecutive readings recommended by the American Heart Association. Also, inspection of collected BP data revealed a strong terminal digit preference (rounding off readings to the nearest zero value, i.e., the nearest 10 mmHg unit) (23).

In addition to changes in systolic blood pressure (SBP) and diastolic blood pressure (DBP), we also reported changes in pulse pressure (PP) and mean arterial pressure (MAP). Recent evidence suggested PP as a reliable independent predictor of CVD risk and as an important marker of arteriovascular physiopathologic status (24). MAP is the average arterial pressure throughout one cardiac cycle, and it is also known as the steady component of BP (25). MAP is a better predictor for stroke and cerebrovascular events while PP is the main predictor of cardiac events (26). PP was calculated as the difference between SBP—DBP. MAP was calculated as DBP + 0.412*(SBP-DBP) (27). BP change since baseline was calculated separately for 6 and 12 months after baseline.

Potential Confounding Factors

Potentially confounding factors were selected from known risk factors for BP (28–30). We first created a "kitchen sink" regression model including all selected variables and performed backward selection, following recommendations by Vittinghoff et al. (31). Predictors of primary interest (age, gender, and years of education as a proxy for socioeconomic status) and confounding variables important for face validity (personal history of hypertension) were forced into the model. The remaining variables were evaluated one at a time in the full kitchen sink model and those meeting our criterion for selection (i.e., if removal from the model produced an absolute BP change of at least 0.2 mmHg) were retained. The final model included age (years), gender, years of education, personal history of hypertension, alcohol drinking (never; occasionally: $\geq$ 3 consecutive drinks two to five times per year; frequently: $\geq$ 3 consecutive drinks at least once per month), body mass index, resting heart rate, LDL cholesterol, job strain ratio, absenteeism days during the year preceding the baseline evaluation, and work shift (morning; accumulated; evening, night, or mixed). Because some continuous variables lack a meaningful zero point, we centered those continuous predictors around the mean value from the sampled subjects (32, 33). Most covariates were collected by the health risk assessment questionnaire and

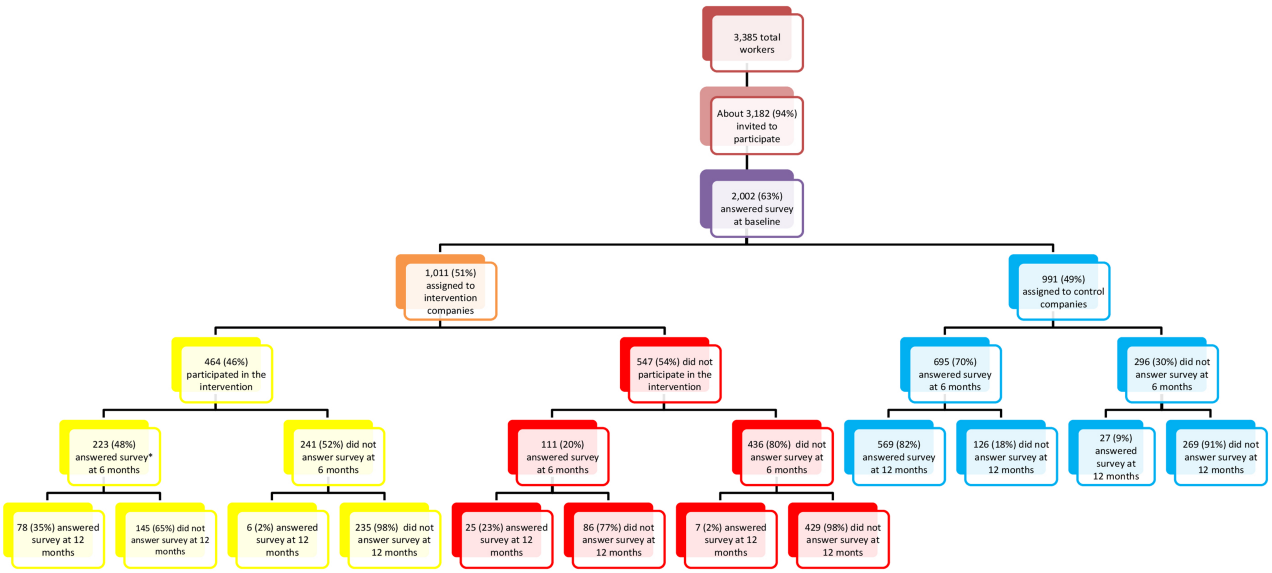

FIGURE 1 | Study population at baseline, 6-month, and 12-month follow-up. Mexican Institute of Social Security study 2009.

detailed descriptions of their measurement are provided in **Supplementary Appendix 1**.

Statistical Analysis

To evaluate the effect of the intervention on the main outcomes, we performed multilevel (linear mixed) analyses, which consider the correlation of repeated measures and combine both random and fixed effects (34). We explored differences between intervention and control companies using intent-to-treat (ITT), per-protocol (PerP), and as-treated (AsTr) analyses. ITT analysis estimated the intervention effect "*as assigned*" and included outcome data for all participants regardless of their adherence to the assigned intervention or missed assessment encounters. In contrast, PerP and AsTr analyses evaluated the effect of the intervention "*as received*" to account for non-adherence. The difference between these two latter methods was the exclusion of non-adherers under the PerP approach (35). In our study, non-adherence was defined as zero participation in any of the intervention components among workers from intervention companies.

To account for loss to follow-up we used *inverse probability of censoring weighting*. In this method, complete cases are weighted by the inverse of their probability of not being censored or lost to follow-up, modeled as function of demographic and other characteristics preceding the timing of the non-loss-to-follow-up. Further, we used a stabilizing factor to normalize the weight (with effect analytical sample size being the size of the observed sample) and to obtain a narrower range of the weight (36). In our study, inverse probability of censoring weighting proved to be a superior method than multiple imputation because most of our missing data were due to non-participation: participants had complete data; non-participants had none (37). Moreover, this method served to avoid fallacious statistical significance due to an inflated sample size (38).

We also investigated within (pre-post) differences among workers who participated in the intervention, separately for its different components. Moreover, we performed secondary analyses to determine if the intervention reached high-risk worker sub-populations: we stratified our mixed models by different baseline risk factor levels of income, body mass index, blood glucose levels, and BP. These analyses are available online as **Supplemental Material**.

All effect estimates are reported with 95% confidence intervals. For ITT analyses, confidence intervals were bootstrapped using 1,000 draws (39). Data were analyzed using Stata version 14.0.

Ethics Review and Approval

The study was reviewed and approved by IMSS Institutional Review Board, which has an approved assurance and registration from the Office for Human Research Protections, US Department of Health and Human Services [Department of Health and Human Services, 2009] (registry number IORG0002957). For our study, we also obtained approval from the University of California, Los Angeles (UCLA) Institutional Review Board (IRB#10–000652-CR-00002). The UCLA Institutional Review Board's Federal- wide Assurance with the Department of Health and Human Services is FWA00004642.

RESULTS

Study Population Characteristics

Of 3,182 eligible workers in all seven companies who were invited to participate, 2002 (63%) participated in baseline assessments; 51% of participants belonged to intervention companies and 49% to control companies (**Figure 1**). Companies with the lowest participation rates included the airline company (37.3%) followed by the tire company (54.7%), while the metalworking company and the plastic factory had complete

(100%) participation rates. All companies in Mexico are required by law to report an annual medical exam for their workers. The two companies with complete participation rates utilized this study's baseline health risk assessment to comply with such requirement. Worker participation by intervention component is summarized in **Supplementary Table A**.

Table 1 describes the demographic, biological, behavioral, psychosocial, and work-related characteristics of our sample. Participants were mostly male. The proportion of workers in high-income occupations (defined as above the poverty level for a family of four or > 162,000 Mexican pesos annual income, equivalent to ∼8,100 USD) was over 8 times greater in intervention companies and workers in these companies had 4.4 more years of education compared to control companies. Intervention companies were mostly comprised of white-collar employees (professionals, managers, technicians) while control companies had mostly blue-collar (elementary manual labor) workers.

Intervention Effects

Between-Group Analyses

ITT Analyses

Differences in average BP change were small and imprecise at 6 months. At 12 months, differences indicated more substantial BP reductions of around −1 mmHg in intervention companies compared to control companies, after adjusting for potential confounders (**Table 2**). The maximum differences were observed for SBP (−1.6 mmHg; 95% CI −3.7, 0.6) and MAP (−1.1 mmHg; 95% CI −2.9, 0.6) at 12-month follow-up. Estimates at 12 months were still imprecise, and bootstrapped estimators in general resulted in wider confidence intervals (**Supplementary Table B**) than confidence intervals derived by robust estimators with inverse probability of censoring weighting.

PerP and AsTr Analyses

PerP analyses, as seen in **Supplementary Table C**, comparing workers from intervention companies who participated in any offered intervention sessions with those who did not yielded maximum reductions in SBP and PP (average change of −0.6 mmHg) at 12 months. Effect sizes were up to three-fold smaller compared to ITT analyses. Consistent small BP increases of about +0.2 mmHg were observed in PerP analyses at 6 months. AsTr analyses followed the same pattern but effect sizes were even smaller. Between-group BP changes by specific intervention component are displayed in **Supplementary Table D**.

Within-Group Analyses

Within-group analyses (**Supplementary Tables E, F**) showed consistent BP reductions, which were more substantial at 12 months (up to−5 mmHg in SBP (95% CI−7.5,−2.6) and−4.8 mmHg in PP (95% CI−8.9,−0.8) for the exercise component).

Secondary Analyses Stratified by Selected Baseline CVD Risk Factors

In secondary sub-group analyses by high-risk status (**Supplementary Tables G–J**), the largest differences in BP reductions were observed for SBP among workers with diabetes at baseline: up to −13.0 mmHg (95% CI −16.0, −10.1) at 12 months follow-up between workers in intervention companies compared to those in control companies (**Supplementary Table I**). Analyses stratified by hypertension status at baseline showed substantial increases of 5–6 mmHg in MAP in workers with elevated BP at baseline (**Supplementary Table J**).

DISCUSSION

Between-Group Differences in BP Change

ITT analyses revealed only small and imprecise changes post intervention at 6 months but notable differences of about −1 mmHg at 12 months, with a maximum difference of −1.6 mmHg for SBP among employees working in intervention companies compared to those employed in control companies. Similar patterns albeit with smaller effect sizes were observed in PerP and AsTr analyses.

Are the Observed Modest Intervention Effects Biologically Significant?

Our primary analyses using the recommended ITT approach reveal modest but still substantial BP reductions in intervention companies relative to control companies. We consider a 1-mmHg difference in BP change and actually any difference >0.2 mmHg as substantial for several reasons. First, such changes are comparable to yearly BP changes observed in aging populations. For example, ambulatory SBP among normotensive and treated hypertensive seniors increased 0.4 mmHg per year of age, whereas ambulatory DBP decreased 0.2 mmHg per year of age (40). Moreover, previous epidemiological research has shown that 1 to 2 mmHg reductions in BP at the population level can have a meaningful impact on the incidence of CVD. Specifically, several meta-analyses summarized by Grossman (41) reported that a 1 mmHg SBP reduction decreases the risk of stroke by 5%. Another study, assuming a practical realistic intervention scenario targeted to those with elevated BP, indicated that 1 mmHg reduction was associated with 20.3 and 13.3 fewer heart failure events per 100,000 person-years in African Americans and whites, respectively (42); i.e., a 0.2 mmHg would be associated with 4.1 and 2.7 fewer heart failure events per 100,000 person-years, respectively. Nationwide, this small BP reduction among African Americans and white US populations aged 45 to 64 years would prevent ∼1,868 incident heart failure events annually. It is likely that a similar BP reduction would have a greater impact among Hispanic populations as they are generally exposed to a greater number of coronary heart disease risk factors such as lower socioeconomic status, education, and less access to health care (43).

Comparison With Previous Studies

Our WHP program achieved better results when compared to other studies using an ITT approach. The few recently published, peer-reviewed randomized controlled studies on the effects of multicomponent health promotion programs on BP that used an ITT approach show inconsistent results. A randomized clinical trial of a multiyear, multicomponent workplace wellness program

TABLE 1 | Characteristics of worker sample in the Mexican Institute of Social Security Study 2009 ($n = 2,002$).

Variable	Intervention companies		Control companies		Total	
	n	Frequency (%) or mean (SD)	*n*	Frequency (%) or mean (SD)	*n*	Frequency (%) or mean (SD)
Demographic						
Gender						
Male	616	60.9	649	65.5	1,265	63.2
Female	395	39.1	342	34.5	737	36.8
Age (years)	1,011	37.5 (10.1)	991	36.1 (11.1)	2,002	36.8 (10.6)
Marital status						
Married	469	46.5	435	43.9	904	45.2
Non-married	540	53.5	555	56.1	1,095	54.8
Education (years)	1,008	14.0 (3.5)	991	9.6 (3.1)	1,999	11.8 (3.9)
Personal annual income (in Mexican pesos)[a]						
Low (<54,000)	175	8.8	658	32.9	833	41.7
Medium (54,001–162,000)	483	24.2	286	14.3	769	38.5
High (>162,000)	352	17.6	45	2.3	397	19.9
Biological						
Height (meters)	1,011	1.6 (0.1)	991	1.6 (0.1)	2,002	1.6 (0.1)
Weight (kilograms)	1,011	72.8 (13.8)	991	69.3 (14.1)	2,002	71.1 (14.0)
BMI (kg/m^2)	1,011	26.9 (4.0)	989	26.7 (4.0)	2,000	26.8 (4.4)
Overweight/obesity[b]						
Yes	677	67.0	605	61.1	1,282	64
No	334	33.0	386	39.0	720	36
Systolic blood pressure (mmHg)	1,011	118.2 (9.9)	991	118.2 (10.7)	2,002	118.2 (10.3)
Diastolic blood pressure (mmHg)	1,011	78.4 (7.1)	991	79.3 (6.6)	2,002	78.8 (6.9)
Hypertension[c]						
Yes	799	79.0	841	84.9	1,640	81.9
No	212	21.0	150	15.1	362	18.1
Resting heart rate (beats/min)	1,001	82.8 (12.2)	988	82.0 (11.2)	1,989	82.4 (11.7)
Blood lipids						
LDL cholesterol (mg/dl)	878	82.7 (29.1)	657	76.3 (30.1)	1,535	79.9 (29.7)
HDL cholesterol (mg/dl)	1,010	39.1 (13.2)	991	34.5 (12.9)	2,001	36.8 (13.3)
Triglycerides (mg/dl)	1,010	139.4 (82.1)	991	142.5 (105.0)	2,001	140.9 (94.1)
Diabetes[d]						
Yes	46	4.6	94	9.5	140	7.0
No	965	95.5	897	90.5	1,862	93.0
Behavioral						
Smoking						
Yes	441	43.6	496	50.1	937	46.8
No	570	56.4	495	50.0	1,065	53.2
Leisure-time physical activity (at least 2x/week)						
Yes	269	26.6	222	22.4	491	24.5
No	742	73.4	769	77.6	1,511	75.5
Alcohol drinking (>3 drinks at least 5x/year)						
Yes	837	82.8	724	73.0	1,561	78.0
No	174	17.2	267	27.0	439	22.0
Diet						
Predominantly fruits & vegetables	191	18.9	147	14.8	338	16.9
Predominantly carbohydrates & grains	152	15.0	281	28.4	433	21.6
Predominantly foods of animal origin	668	66.1	563	56.8	1,231	61.5

(Continued)

TABLE 1 | Continued

Variable	Intervention companies		Control companies		Total	
	n	Frequency (%) or mean (SD)	*n*	Frequency (%) or mean (SD)	*n*	Frequency (%) or mean (SD)
Work-related						
Psychosocial (JCQ score)[e]						
Job strain	1,011	0.8 (0.2)	991	0.9 (0.2)	2,002	0.9 (0.2)
Coworker support	1,011	12.5 (2.0)	991	12.1 (2.2)	2,002	12.3 (2.1)
Supervisor support	1,011	12.4 (2.8)	991	12.5 (2.7)	2,002	12.4 (2.7)
Occupation						
Managers	71	7.0	35	3.5	106	5.3
Professionals	337	33.3	21	2.1	358	17.9
Technicians & associated professionals	186	18.4	55	5.6	241	12.0
Clerical support workers	174	17.2	63	6.4	237	11.8
Service & sales workers	-	-	14	1.4	14	0.7
Craft & related trades workers	56	5.5	82	8.3	138	6.9
Plant & machine operators & assemblers	51	5.0	259	26.1	310	15.5
Elementary occupations (manual labor)	136	13.5	462	46.6	598	29.9
Worksites						
Public Health	123	6.1	-	-	123	6.1
Airline	703	35.1	-	-	703	35.1
Pharmaceutical	185	9.2	-	-	185	9.2
Tools manufacture	-	-	161	8	161	8
Cooking utensils manufacture	-	-	108	5.4	108	5.4
Plastic factory	-	-	95	4.8	95	4.8
Printing company	-	-	627	31.3	627	31.3
Contract type						
Permanent	812	80.6	729	73.6	1,541	77.1
Temporary	196	19.4	261	26.4	457	22.9
Shift						
Morning	771	76.3	441	44.7	1,212	60.7
Evening	26	2.6	21	2.1	47	2.3
Night	13	1.3	5	0.5	18	0.9
Mixed	189	18.7	513	52.0	702	35.2
Double shift	12	1.2	6	0.6	18	0.9
Seniority (years)	1,011	8.6 (9.0)	990	5.2 (6.9)	2,001	6.9 (8.2)
Sick leave (days during year of evaluation)	943	2.6 (11.2)	953	3.2 (13.8)	1,896	2.9 (12.6)
Physical work demands						
Vigorous	85	8.6	261	26.8	346	17.7
Moderate	278	28.2	391	40.1	669	34.1
Light	622	63.2	323	33.1	945	48.2

[a]*$1.00 US dollar ≈ $19.09 MX pesos. As of December 2018, the minimum wage in Mexico was $88.36MX per day ($11.05 per hour) [Banco de Mexico, 2018]. The annual minimum wage is about $22,090.00MX (2,000 working hours/year* 11.05), which is approximately equivalent to $1,157.15 US dollars.*

[b]*Overweight/obesity determined using the World Health Organization's cutoffs: Body mass index ≥ 25 kg/m^2.*

[c]*Determined by self-report and on-site measurement; classified using the American Heart Association (AHA) cutoffs (systolic blood pressure ≥ 130mmHg or diastolic blood pressure ≥ 80 mmHg).*

[d]*Determined by self-report and on-site measurement; classified using the World Health Organization cutoff ≥ 126 mg/dL.*

[e]*JCQ, Job Content Questionnaire.*

implemented among 32,974 employees at a large US warehouse retail company found that individuals in workplaces where the program was offered reported better health behaviors but neither differences in BP nor other clinical measures of health after 18 months were observed (44). Another large randomized clinical trial among 4,834 university employees found no effects on BP or other clinical health outcomes after a 30-month wellness program (45).

A systematic review of 31 studies between 1980 and 2005 that used an assessment of health risks (including BP) combined

TABLE 2 | Between-group differences in blood pressure change from baseline to 6 and 12 months after intervention.

	ITT			
	Delta[a] crude	**Delta adjusted[b]**	**95% CI**	***p*-value**
Systolic blood pressure (mmHg)				
6 months	0.5	0.2	−1.4, 1.8	0.79
12 months	−1.2	−1.6	−3.7, 0.6	0.16
Diastolic blood pressure (mmHg)				
6 months	0.5	0.0	−1.6, 1.6	0.99
12 months	−0.2	−0.8	−2.3, 0.7	0.31
Pulse pressure (mmHg)				
6 months	0.0	0.2	−0.5, 0.9	0.60
12 months	−1.3	−0.8	−2.0, 0.4	0.18
Mean arterial pressure (mmHg)				
6 months	0.5	0.1	−1.5, 1.7	0.92
12 months	−0.6	−1.1	−2.9, 0.6	0.20

Intent-to-treat analysis (ITT).
Results are based on a mixed-model analysis using inverse probability of censoring weights.
[a]*Delta: regression coefficient.*
[b]*Adjusted for demographic, biological, behavioral, psychosocial, and work-related variables.*

with WHP interventions reported a median decrease of −2.6 mmHg SBP and −1.8 mmHg DBP in favor of the intervention using within-group pre-post analyses (46), which is comparable with the lower range of our within-group results. However, our achieved reductions of BP appear smaller compared to clinical interventions among patients in a health-care setting (47).

Since lowering BP is necessary to limit the most serious (including fatal) complications of hypertension, it is important to find alternatives that would reduce the doses of or the need for anti-hypertensive medication. Antihypertensive medication is frequently associated with adverse effects, which may result in non-compliance to treatment and lower quality of life (48, 49). Therefore, primary prevention of modifiable CVD risk factors before manifestation of hypertension or an initial CVD event is preferable to and more effective than cardiac rehabilitation (50), thus making WHP an appealing approach to prevent the onset of morbidities that would require medications.

Strengths

Strengths of the current study include its large and relatively heterogeneous sample with respect to age, gender, occupation, and industry. The frequency, duration, and content of all components of the intervention have been thoroughly described and this is one of the first intent-to-treat WHP studies in a middle-income country. Also, unlike other multicomponent intervention programs (44), this study was able to explore the separate effects of the different components of this health promotion program. Another strength was the one-year length of follow-up that enabled us to evaluate long-term sustainability of effects.

In addition to SBP and DBP, our study also evaluated PP and MAP. All of our analyses were based considering these four BP components and throughout this paper we mostly reported on SBP and DBP or on consistent overall effects across different BP measures. There were some instances where either SBP or DBP alone would not depict a definite result but when looking at PP and/or MAP a clearer pattern would emerge, particularly in regards to the overall direction of effects (BP reduction or increase).

Limitations

One important limitation relates to BP measurement. A standardized procedure was not strictly followed as we had only one measurement at a time instead of the two or more consecutive readings recommended by the American Heart Association (22). Additionally, we noted a terminal-digit preference, which may point to insufficient training or supervision of the staff in charge of taking BP measurements, which limited our ability to accurately measure BP changes and most likely led to non-differential misclassification and an underestimation of reported effect sizes.

As with any non-randomized study, non-measured factors could not be controlled and we cannot rule out the possibility that individuals who work in the control companies may be structurally different from those in the intervention companies.

Follow-up data were frequently missing. We addressed this limitation by using a linear mixed model analysis [known for its ability to give unbiased results in the presence of missing data (51)] and applying inverse probability of censoring weighting that accounted for incomplete data (37).

The intervention program might not have been state-of-the-art. Public health knowledge is always evolving and what is considered best practice now may not have been promoted 10 years ago. For example, our nutrition intervention component included dietary recommendations to reduce caloric intake according to gender and general physical activity but did not consider the caloric needs due to occupational physical activity. This is important because even occupations with moderate

activity result in a daily energy expenditure of at least 1,680 kcal in an eight-hour shift (52). A better approach could be to change the composition of meals: more protein and less starch and sugar to fulfill workers' caloric needs while improving their CVD risk (53).

Finally, although this population was diverse, results may not generalize to other workplace settings or populations. Participation was voluntary in some companies, which may have introduced selection bias. However, randomization and representativeness in such workplace-based trials can hardly be achieved because it is extremely difficult to randomly recruit workplaces.

CONCLUSION

Our primary analyses using the recommended ITT approach revealed differences of about −1 mmHg at 12 months in intervention companies relative to control companies. This finding was consistent with PerP and AsTr analyses. Within-group analyses showed BP reductions at both 6 and 12 months, with effect sizes up to four-fold larger than those found with between-group comparisons. Although individuals with low CVD risk factors at baseline seemed to benefit most from the intervention, people with diabetes who participated in the intervention showed the largest reductions of up to −13.0 mmHg for SBP at 12-months follow-up. However, because BP increases among individuals with Stage II hypertension at baseline were observed, recommendations for this type of intervention need to be made with caution and should take into consideration baseline CVD risk factors. Confirmatory WHP studies targeted to these high-risk populations are warranted.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by IMSS Institutional Review Board (IRB), which has an approved assurance and registration from the Office for Human Research Protections, US Department of Health and Human Services [Department of Health and Human Services, 2009] (registry number IORG0002957). For our study, we also obtained approval from the University of California, Los Angeles (UCLA) IRB (IRB#10–000652-CR-00002). The UCLA IRB's Federal- wide Assurance with the Department of Health and Human Services is FWA00004642. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

IG-R is the main author and was responsible for the conception, design, data acquisition, analysis, and interpretation for the work. NK and NO along with the main author drafted the work and revised it critically for important intellectual content and participated in the analysis, and interpretation of data. OA provided guidance and valuable insight for the analysis, and interpretation of data for the work. All authors gave the final approval of the version to be published.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.683655/full#supplementary-material

REFERENCES

1. Gaziano TA, Bitton A, Anand S, Abrahams-Gessel S, Murphy A. Growing epidemic of coronary heart disease in low- and middle-income countries. *Curr Probl Cardiol.* (2010) 35:72–115. doi: 10.1016/j.cpcardiol.2009.10.002
2. Takala J, Hamalainen P, Saarela KL, Yun LY, Manickam K, Jin TW, et al. Global estimates of the burden of injury and illness at work in 2012. *J Occup Environ Hyg.* (2014) 11:326–37. doi: 10.1080/15459624.2013.863131
3. Institute for Health Metrics and Evaluation. *GBD Compare Data Visualization*. (2017). Available online at: https://vizhub.healthdata.org/gbd-compare/ (accessed May 27, 2021).
4. Arredondo A, Orozco E, Alcalde-Rabanal J, Navarro J, Azar A. Challenges on the epidemiological and economic burden of diabetes and hypertension in Mexico. *Revista de Saude Publica.* (2018) 52:23. doi: 10.11606/s1518-8787.2018052000293
5. Sudharsanan N, Geldsetzer P. Impact of coming demographic changes on the number of adults in need of care for hypertension in Brazil, China,

India, Indonesia, Mexico, and South Africa. *Hypertension.* (2019) 73:770–6. doi: 10.1161/hypertensionaha.118.12337
6. World Health Organization. *Workplace Health Promotion*. (2019). Available online at: https://www.who.int/occupational_health/topics/workplace/en/ (accessed May 27, 2021).
7. Corbett DB, Fennell C, Peroutky K, Kingsley JD, Glickman EL. The effects of a 12-week worksite physical activity intervention on anthropometric indices, blood pressure indices, and plasma biomarkers of cardiovascular disease risk among university employees. *BMC Res Notes.* (2018) 11:80. doi: 10.1186/s13104-018-3151-x
8. Ho JTS. Worksite health promotion and wellness programs. In: Smelser NJ, Baltes PB, editors. *International Encyclopedia of the Social & Behavioral Sciences*. Oxford: Pergamon (2001). p. 16604–9. doi: 10.1016/B0-08-043076-7/03891-2
9. Wipfli H, Zacharias KD, Nivvy Hundal N, Shigematsu LMR, Bahl D, Arora M, et al. Workplace wellness programming in low-and middle-income countries: a qualitative study of corporate key informants in Mexico and India. *Glob Health.* (2018) 14:46. doi: 10.1186/s12992-018-0362-9
10. Anthony D, Dyson PA, Lv J, Thankappan KR, Fernandez MT, Matthews DR. Reducing health risk factors in workplaces of low and middle-income countries. *Public Health Nurs.* (2015) 32:478–87. doi: 10.1111/phn.12189
11. Lara A, Yancey AK, Tapia-Conye R, Flores Y, Kuri-Morales P, Mistry R, et al. Pausa para tu Salud: reduction of weight and waistlines by integrating exercise breaks into workplace organizational routine. *Prev Chronic Dis.* (2008) 5:A12.
12. Maldonado-Islas G, Mancera-Perez A. Uso y control del estrés. Progama aplicado a trabajadores del IMSS. *Gac Med Mex.* (1997) 133:7–11.
13. Rullan A, Garcia J, Alvarez M, Talavera JO, Chu Y, Clark P. Effects of a comprehensive health and wellness program on administrative employees of a corporation in Mexico. *J Community Med Health Educ.* (2014) 4:303–9. doi: 10.4172/2161-0711.1000303
14. Schroer S, Haupt J, Pieper C. Evidence-based lifestyle interventions in the workplace–an overview. *Occup Med.* (2014) 64:8–12. doi: 10.1093/occmed/kqt136
15. Kaspin LC, Gorman KM, Miller RM. Systematic review of employer-sponsored wellness strategies and their economic and health-related outcomes. *Popul Health Manag.* (2013) 16:14–21. doi: 10.1089/pop.2012.0006
16. Sanchez-Roman FR, Juarez-Perez CA, Aguilar Madrid G, Haro-Garcia L, Borja-Aburto VH, Claudio L. Occupational health in Mexico. *Int J Occup Environ Health.* (2006) 12:346–54. doi: 10.1179/oeh.2006.12.4.346
17. Garcia-Rojas IJ. *Associations of job strain, isostrain, and job insecurity with cardiovascular risk factors and productivity in Mexican workers* (doctoral dissertation). University of California, Los Angeles, Los Angeles, CA, United States (2014). Available online at: https://search.proquest.com/docview/1508269488?accountid=14512 (accessed May 27, 2021).
18. World Health Organization. *Body Mass Index*. (2019). Available online at: http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi (accessed May 27, 2021).
19. Official Mexican Standard NOM-043-SSA2-2005. *Basic Health Services. Health Promotion and Education in Nutrition Matters. Criteria to Provide Guidance* (2006).
20. Pollock ML, Gaesser GA, Butcher JD, Després J-P, Dishman RK, Franklin BA, et al. ACSM position stand: the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc.* (1998) 30:975–91.
21. Richardson KM, Rothstein HR. Effects of occupational stress management intervention programs: a meta-analysis. *J Occup Health Psychol.* (2008) 13:69–93. doi: 10.1037/1076-8998.13.1.69
22. Muntner P, Shimbo D, Carey RM, Charleston JB, Gaillard T, Misra S, et al. Measurement of blood pressure in humans: a scientific statement from the american heart association. *Hypertension.* (2019) 73:e35–66. doi: 10.1161/hyp.0000000000000087
23. Beevers G, Lip GY, O'Brien E. ABC of hypertension: Blood pressure measurement. Part II-conventional sphygmomanometry: technique of auscultatory blood pressure measurement. *BMJ.* (2001) 322:1043–7. doi: 10.1136/bmj.322.7293.1043
24. Randall OS, Kwagyan J, Huang Z, Xu S, Ketete M, Maqbool AR. Effect of diet and exercise on pulse pressure and cardiac function in morbid obesity: analysis of 24-hour ambulatory blood pressure. *J Clin Hypertens.* (2005) 7:455–63. doi: 10.1111/j.1524-6175.2005.04491.x
25. DeMers D, Wachs D. *Physiology, Mean Arterial Pressure*. StatPearls. Treasure Island, FL: StatPearls Publishing LLC (2019).
26. Verdecchia P, Schillaci G, Reboldi G, Franklin SS, Porcellati C. Different prognostic impact of 24-hour mean blood pressure and pulse pressure on stroke and coronary artery disease in essential hypertension. *Circulation.* (2001) 103:2579–84. doi: 10.1161/01.cir.103.21.2579
27. Meaney E, Alva F, Moguel R, Meaney A, Alva J, Webel R. Formula and nomogram for the sphygmomanometric calculation of the mean arterial pressure. *Heart.* (2000) 84:64. doi: 10.1136/heart.84.1.64
28. Whelton PK, Carey RM, Aronow WS, Casey DE, Jr., Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary: a report of the american college of cardiology/american heart association task force on clinical practice guidelines. Hypertension. (2018). 71:1269–324. doi: 10.1161/hyp.0000000000000066
29. Borghi C. Hypertension: quo vadis? *Curr Vasc Pharmacol.* (2012) 10:739–42. doi: 10.2174/157016112803520927
30. Gueyffier F, Boissel JP, Pocock S, Boutitie F, Coope J, Cutler J, et al. Identification of risk factors in hypertensive patients: contribution of randomized controlled trials through an individual patient database. *Circulation.* (1999) 100:e88–94.
31. Vittinghoff E, Shiboski SC, Glidden DV, McCulloch CE. *Predictor Selection. Regression Methods in Biostatistics*. New York, NY: Springer (2005). p. 133–56.
32. National Institute of Mental Health. *When and How to Center a Variable?* (2019). Available online at: https://afni.nimh.nih.gov/pub/dist/doc/htmldoc/statistics/center.html (accessed May 27, 2021).
33. Enders CK, Tofighi D. Centering predictor variables in cross-sectional multilevel models: a new look at an old issue. *Psychol Methods.* (2007) 12:121–38. doi: 10.1037/1082-989x.12.2.121
34. Diez Roux AV. The study of group-level factors in epidemiology: rethinking variables, study designs, and analytical approaches. *Epidemiol Rev.* (2004) 26:104–11. doi: 10.1093/epirev/mxh006
35. Ten Have TR, Normand SL, Marcus SM, Brown CH, Lavori P, Duan N. Intent-to-treat vs. non-intent-to-treat analyses under treatment non-adherence in mental health randomized trials. *Psychiatr Annals.* (2008) 38:772–83. doi: 10.3928/00485713-20081201-10
36. Hernán M, Robins J. *Inverse Probability Weighting and Marginal Structural Models. Causal Inference 2.* Boca Raton, FL: Chapman & Hall/CRC (2018). p. 11–22.
37. Seaman SR, White IR. Review of inverse probability weighting for dealing with missing data. *Statist Methods Med Res.* (2013) 22:278–95. doi: 10.1177/0962280210395740
38. Mascha EJ, Vetter TR. Significance, errors, power, and sample size: the blocking and tackling of statistics. *Anesth Anal.* (2018) 126:691–8. doi: 10.1213/ane.0000000000002741
39. Field CA, Welsh AH. Bootstrapping clustered data. *J R Statist Soc Series B.* (2007) 69:369–90. doi: 10.1111/j.1467-9868.2007.00593.x
40. Wendelin-Saarenhovi ML, Isoaho RE, Hartiala JJ, Helenius HY, Kivela SL, Lopponen MK, et al. Ambulatory blood pressure characteristics in normotensive and treated hypertensive older people. *J Hum Hypertens.* (2002) 16:177–84. doi: 10.1038/sj.jhh.1001318
41. Grossman E. Blood pressure: the lower, the better: the con side. *Diabetes Care.* (2011) 34 Suppl 2:S308–12. doi: 10.2337/dc11-s245
42. Hardy ST, Loehr LR, Butler KR, Chakladar S, Chang PP, Folsom AR, et al. Reducing the blood pressure-related burden of cardiovascular disease: impact of achievable improvements in blood pressure prevention and control. *J Am Heart Assoc.* (2015) 4:e002276. doi: 10.1161/jaha.115.002276
43. Balfour PC Jr, Ruiz JM, Talavera GA, Allison MA, Rodriguez CJ. Cardiovascular Disease in Hispanics/Latinos in the United States. *J Latin Psychol.* (2016) 4:98–113. doi: 10.1037/lat0000056
44. Song Z, Baicker K. Effect of a workplace wellness program on employee health and economic outcomes: a randomized clinical trial. *JAMA.* (2019) 321:1491–501. doi: 10.1001/jama.2019.3307

45. Reif J, Chan D, Jones D, Payne L, Molitor D. Effects of a workplace wellness program on employee health, health beliefs, and medical use: a randomized clinical trial. *JAMA Int Med.* (2020) 180:952–60. doi: 10.1001/jamainternmed.2020.1321
46. Soler RE, Leeks KD, Razi S, Hopkins DP, Griffith M, Aten A, et al. A systematic review of selected interventions for worksite health promotion. The assessment of health risks with feedback. *Am J Prev Med.* (2010) 38(2 Suppl):S237–62. doi: 10.1016/j.amepre.2009.10.030
47. Glynn LG, Murphy AW, Smith SM, Schroeder K, Fahey T. Interventions used to improve control of blood pressure in patients with hypertension. *Cochrane Database Syst Rev.* (2010) 2010:Cd005182. doi: 10.1002/14651858.CD005182.pub4
48. Tinetti ME, Han L, Lee DS, McAvay GJ, Peduzzi P, Gross CP, et al. Antihypertensive medications and serious fall injuries in a nationally representative sample of older adults. *JAMA Int Med.* (2014) 174:588–95. doi: 10.1001/jamainternmed.2013.14764
49. Bardage C, Isacson DG. Self-reported side-effects of antihypertensive drugs: an epidemiological study on prevalence and impact on health-state utility. *Blood Pressure.* (2000) 9:328–34. doi: 10.1080/080370500300000905
50. Arena R, Guazzi M, Briggs PD, Cahalin LP, Myers J, Kaminsky LA, et al. Promoting health and wellness in the workplace: a unique opportunity to establish primary and extended secondary cardiovascular risk reduction programs. *Mayo Clin Proc.* (2013) 88:605–17. doi: 10.1016/j.mayocp.2013.03.002
51. Krueger C, Tian L. A comparison of the general linear mixed model and repeated measures ANOVA using a dataset with multiple missing data points. *Biol Res Nurs.* (2004) 6:151–7. doi: 10.1177/1099800404267682
52. Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR, Jr., Tudor-Locke C, et al. 2011 compendium of physical activities: a second update of codes and MET values. *Med Sci Sports Exerc.* (2011). 43:1575–81. doi: 10.1249/MSS.0b013e31821ece12
53. Taubes G. *Good Calories, Bad Calories*. New York, NY: Anchor (2007). p. 640.

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Mental Workload and Job Satisfaction in Healthcare Workers: The Moderating Role of Job Control

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Objective: The aim of this study was to investigate the moderating role of job control in relation to mental workload and job satisfaction of healthcare workers.

Methods: This cross-sectional study was carried out on 480 nurses, midwives, and administrative workers in four educational hospitals of Ardabil, Iran. Research tools were included demographic information questionnaire, NASA-TLX questionnaire, job description index (JDI) questionnaire and job control inquiry.

Results: Compared with administrative workers, mental workload of nurses and midwives was significantly higher and likewise mental workload of nurses was significantly difference compared to midwives ($P < 0.001$). Nurses and midwives had substantially higher job satisfaction than administrative workers ($P < 0.001$). Also, nurses and midwives had higher job control than administrative workers ($P < 0.001$ and $P = 0.002$, respectively). Based on the designed model, the correlation between mental workload and job satisfaction was negative and significant ($r = -0.22$); which in the presence of job control, the relationship between the two variables of workload and job satisfaction slightly increased ($r = -0.19$, $P < 0.001$). These conditions were the same in the three job groups separately.

Conclusion: Mental workload is inversely related to job satisfaction and job control. Job control plays an important role in improving working conditions in healthcare workers.

Keywords: job satisfaction, job control, mental workload, healthcare worker, hospital

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INTRODUCTION

Hospitals are considered as the most hazardous centers for providing services in the health system (1) and healthcare workers, as the caregivers of patients, are exposed to various occupational hazards include exposure to biological, chemicals, physical, safety, and ergonomic and psychosocial agents (2, 3). The outbreak of occupational hazards in healthcare workers has been reported differently (4). According to a national survey in the United State in 2012, the incidence of occupational injuries and illnesses in health employees and medical care was over 6.6%, which is the highest-ranking among 56 service industries (5). Nurses are more at risk than other working groups due to more communication with patients, long and rotating work shifts, and the resulting

exhaustion (6) so that the outbreak of occupational hazards has been reported four times more than the other occupations in them (7). Midwifery staff also face risks because of some job problems including a lack of knowledge, stress, high demands in the workplace, on-call, and a lack of management support (8). Studies have shown that psychological factors have a significant impact on the occurrence of complaints; as well as work-related accidents (9, 10). Improving the psychological conditions of the workplace and paying attention to these factors can prevent many difficulties and increase the employees' health (11).

Job satisfaction, as a positive emotional factor, is one of the most important psychological factors related to employees and can motivate them (12, 13). Job satisfaction refers to the attitudes of employees toward their jobs. In other words, it is about satisfying and meeting job needs, workload, and effectiveness (10). It is affected by various factors such as salary, communications, policies, job aspects, work order, and personal features of the employees (14, 15). Therefore, in order to increase the job satisfaction, the improvement of working conditions should be targeted (16). Job dissatisfaction of nurses may lead to absenteeism and poor performance and potentially affects the quality of patient care (17). Studies have revealed a positive correlation between the job satisfaction and job performance of nurses and midwives (18–20).

Mental workload is a complicated and multi-aspect structure that is affected by external work needs, environment, psychological and organizational factors, and mental and organizational abilities (21). Workload, as one of the essential components of service delivery in the health system, has a decisive role in undesirable consequences such as emotional exhaustion, depersonalization, and burnout (22). The results of the study conducted by Paneque and Carvajal showed that 86% of employees are exposed to psychological hazards (23). Work-related stresses, of excessive, can endanger a person's health by causing physical, psychological, and behavioral complications (24). Employees, who do not have a good mental health, will not be able to provide adequate patient care. The mental health of the healthcare workers affects the quality of care provided with patients (25). Therefore, in order to provide a proper care by the employees, it is necessary for them to be healthy people; poor mental health can lead to further occupational difficulties in employees.

Hospital professions are classified into a group of jobs with mental workload because of high workload and different job requirements that may be due to large clientele, high workload, shift work, and lack of employees in healthcare workers (26, 27). The health level of the workers increases by preventing and reducing stressors in hospital workplaces, and consequently, their efficiency and effectiveness increase in providing services (28, 29).

Leiter and Maslach stated that job control plays an important role in burnout and the workload of employees. The job control enables workers to make decisions about their work, and on the other hand, a lack of job control means that employees' authority is limited (30). Portoghese et al. also discussed the moderating role of job control on the relationship between workload and burnout (31). This role is based on demand-job control theory as well as extended models of this theory, such as demand-control-performance. With respect to the demand-job control theory, the stress in work environments occurs when the job demands is high and job control is low (32). Other study showed that job control beyond the job demand has a significant predictive power for burnout (33). Therefore, job control as a potential moderator variable can play a good role in patterns such as demand-control-behavioral consequences. This study was aimed at investigating the level of mental workload and job satisfaction of healthcare workers as well as investigating the moderating role of job control in the correlation between mental workload and job satisfaction of the employees.

METHODS

Study Design and Subjects

This cross-sectional study was carried out on healthcare workers in four educational hospitals of Ardabil, Iran, in 2021. The healthcare workers were estimated 720. So, 480 numbers of participants considering the inclusion and exclusion criteria were entered into the study. Participants were included nurses ($n = 188$), midwives ($n = 150$), and administrative workers ($n = 142$). Inclusion criteria involved willingness to cooperate and having more than 1 year of work experience in the hospital, and the persons, who were unwilling to cooperate, were excluded from the study. In addition, since the number of physicians participating in the study was very small they were excluded from the study.

At first, this study was approved by the ethics committee of Shoushtar faculty of Medical Sciences, code no. IR.SHOUSHTAR.REC.1399.043; procedures of this study accorded with principles of declaration of Helsinki (1964) and its later amendments. Then, the necessary coordination was made with the relevant units in the hospitals. The purpose of the study was fully stated for people. The participants were informed about how to fill out the questionnaire along with the administration of the questionnaires. The sampling method was the census and participants expressed their written consent. Data were gleaned using standard questionnaires. Questionnaires including the NASA-TLX questionnaire, job satisfaction questionnaire, and Job Control Assessment (JCA) were used. The demographics information of the participants included age, gender, work experience, education level, primary and second jobs, and type of employment. The hard copies of the questionnaires were distributed to healthcare workers and collected by researchers in 2 weeks. In the present study, the Persian version of the questionnaires was used. In this study, the relationship among workload as an occupational demand and positive behavioral consequences such as job satisfaction, and also job control is considered as the role of a moderating variable, as shown in **Figure 1**.

Mental Workload Questionnaire

NASA-TLX questionnaire is one of the workload assessment methods introduced by Hart and Staveland, and it is widely the most powerful tool available for evaluating perceptual aspects of the workload (34). The NASA-TLX is a multidimensional method that provides an overall score of workload based on a

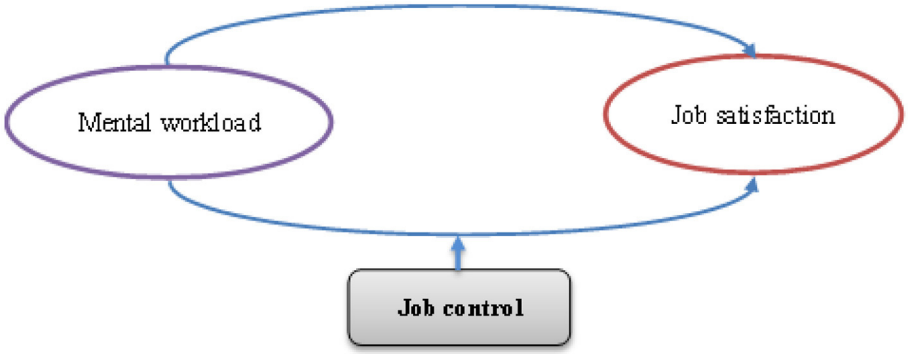

FIGURE 1 | A model of mental workload, the role of job control as a moderating variable, and job satisfaction.

TABLE 1 | Demographic variable.

Variable	Categories		*n* (%)
Job	Nurse		188 (39.2%)
	Midwife		150 (31.2%)
	administrative staff		142 (29.6%)
Education	Associate's degree		20 (4.2%)
	Bachelor		412 (85.8%)
	Master and higher		48 (10.0%)
sex	Male		53 (11%)
	Female		427 (89%)
	Min	**Max(years)**	**Mean ± SD**
Age	22	56	34.01 ± 6.02
Job experience	1	29	7.91 ± 7.25

TABLE 2 | Mean and standard deviation (SD) Scores obtained for NASA-TLX index.

NASA TLX index	Mean	SD
Physical demand	73.33	23.435
Temporal demand	50.23	26.878
Performance demand	73.84	25.856
Effort demand	75.89	19.905
Frustration demand	77.18	22.102
Mental demand	74.01	27.592
Total score for NASA-TLX	70.9896	15.14901

weighted average of six scales including six demands such as mental demand, physical, temporal effort, performance, effort, and frustration (35). In this questionnaire, for each field of activity, it is divided into 100 points with 5-point steps. Many studies have confirmed the reliability and validity of this method for assessing workload (36). This questionnaire was translated into Persian by Mohammadi et al. and its validity and reliability were evaluated and Cronbach's alpha coefficient was 0.847. Weighted averages are computed by multiplying the raw score of each scale by the number of times the associated workload factor was chosen in the paired-choice task, then dividing by the sum of the weights (i.e., 15) (37).

Job Satisfaction Questionnaire

The Job Satisfaction Questionnaire, known as the Job Descriptive Index (JDI), was designed by Smith, Kendall and Huhn at the Cornell University in 1969 (38). This questionnaire is one of the most valid questionnaires used for the evaluation of job satisfaction. It consists of 54 questions and has been used in various studies (16, 39). The Persian version of the questionnaire was measured at Shahid Chamran University of Iran and its validity and reliability coefficients were equal to 0.96 and 0.94, respectively. Its rating scale is five points Likert (1 strongly disagree to 5 strongly agree). The JDI is derived from various aspects of job, such as income, opportunities for promotions, supervisors, colleagues, and work environment factors like supervisors' style, policies and procedures, workgroup affiliation, working conditions, and job benefits (40). The score of each questionnaire is obtained by sum of the scores of questions and total score of job satisfaction is computed by multiplying the score of each questionnaire by the number of questionnaires. The range of score will be 30–150. Job satisfaction status is determined based on the following classification: Score between 30 and 50 Job satisfaction is low, Score between 51 and 102 Job satisfaction is moderate and Score above 102 Job satisfaction is high.

Job Control Assessment

The questionnaire of job control (JCA) designed by Adibi et al. contains five questions based on a 5-point Likert scale (1 strongly agree to 5 strongly disagree). The tool measures the job control by quantifying the employees' perceived control over work affairs, methods of work, policies of work, and perceived autonomy during the work. Cronbach's alpha of the five questions was obtained 0.7 Job control score is computed by summation questions score and multiplying the score obtained from each questionnaire with number of questionnaires. The range of job control score is 5–25 (41).

TABLE 3 | Mean of underlying variables and their relationship with workload, job satisfaction, and job control.

Variable		Mental workload		Job satisfaction		Job control	
		Mean ± SD	*P*-Value	Mean ± SD	*P*-Value	Mean ± SD	*P*-Value
Job	Nurse	77.69 ± 12.13	<0.001*, $F = 56.59$	185.31 ± 54.86	<0.001*, $F = 9.81$	14.38 ± 5.81	NS
	Midwife	71.50 ± 13.16		188.49 ± 54.94		14.47 ± 5.82	
	administrative staff	61.57 ± 15.86		210.54 ± 52.34		15.19 ± 5.48	
Education	Associate's degree	73,055 ± 8.87	0.714, $F = 0.336$	134.05 ± 34.29	<0.001*, $F = 13.70$	12.55 ± 6.00	NS
	Bachelor	70/81 ± 15.55		195.27 ± 25.83		14.71 ± 5.75	
	Master and higher	71.45 ± 13.72		205.75 ± 39.63		14.97 ± 5.20	

Variable	*r*, *P*-value		
Age	0.235, <0.001*	−0.894, <0.001*	−0.051, NS
Job experience	0.224, <0.001*	−0.683, <0.001*	−0.048, NS

*significance level at $p = 0.001$.

Statistical Analysis

Data analyses were performed using SPSS 21 and AMOS 18 software. The quantitative variables were reported as mean ± standard deviation and qualitative variables were stated in numbers (percent). The normality of the quantitative variables was assessed using the Kolmogorov-Smirnov test. The chi-square test was used to investigate the relationship between qualitative variables, and one-way analysis of variance was applied to compare the quantitative variables. The *post hoc* tests were performed for pairwise comparison of the quantitative variables. Pearson correlation coefficient was used to determine the relationship between the quantitative variables. Multivariate analysis of variance (MANOVA) was applied for the role of job control. Structural equation models (SEMs) were used to investigate the other variables when exposed to the moderating variable. The significance level was considered to be < 0.05 ($P < 0.05$).

RESULTS

Demographic and Job Characteristics

Response rate of participants was 73.2% as 527 forms were received back. Of them, 480 were completely filled and segregated for further analyses. Eighty-nine percent of people were women and 11% were men. The hospital staff surveyed in this study nurses and midwives were 39.2 and 31.2%, respectively, and 29.6% of the participants worked in the official units. Most participants were Bachelor of Science (85.8%), followed by postgraduate (10.0%). The demographic characteristics of the hospital staff are listed in **Table 1**.

The Comparison of Mental Workload, Job Satisfaction, and Job Control Scores

The average of mental workload, job satisfaction, and job control scores among all participants was 70.98 ± 15.14, 193.77 ± 55.15, and 14.65 ± 5.65, respectively. The subscales of mental workload (NASA TLX Index) shown in **Table 2**.

The relationship between demographic characteristics as age and work experience with the mental workload, job satisfaction and job control shown in the **Table 3**. The scores of mental workload, job satisfaction, and job control among healthcare workers statistically significant differences among the three groups for job and education ($P < 0.05$). As shown in **Table 3**. After a further comparison between every two groups by Tukey follow-up test, mental workload of nurses was higher significantly than midwives and administrative workers and also mental workload of midwives was significantly difference compared to administrative workers ($P < 0.001$). Nurses and midwives had substantially higher job satisfaction ($P < 0.001$) and job control than administrative workers ($P < 0.001$ and $P = 0.002$, respectively).

The Model Results

Figure 2, designed as model 1a shows the correlation between workload and job satisfaction ($r = -0.22$, $p < 0.001$). According to this model, job satisfaction decreased by increasing the workload. Based on the results in **Table 4**, some goodness of fit indices showed that the designed model has a good fit. In the designed model 1b, the role of job control as mediating variable was plotted. The standard coefficient between the workload and job satisfaction was $r = -0.19$, $p < 0.001$, and the standard coefficient of job control on subjective workload was $r = -0.28$, $p < 0.001$. That is, in the presence of the job control (which has a significant and inverse relationship with the mental workload), the relationship between the two variables of workload and job satisfaction increases slightly. Some goodness of fit indices of the designed model for investigating the correlation between workload and job satisfaction despite the job control showed that the designed model is well-fitted (**Table 4**). According to the results, among the dimensions of mental workload, the highest score was related to effort followed by the pressure of time, and stress, respectively. Among the aspects of job satisfaction variable, the highest score was related to the job nature followed by income and the work environment (**Figure 2**).

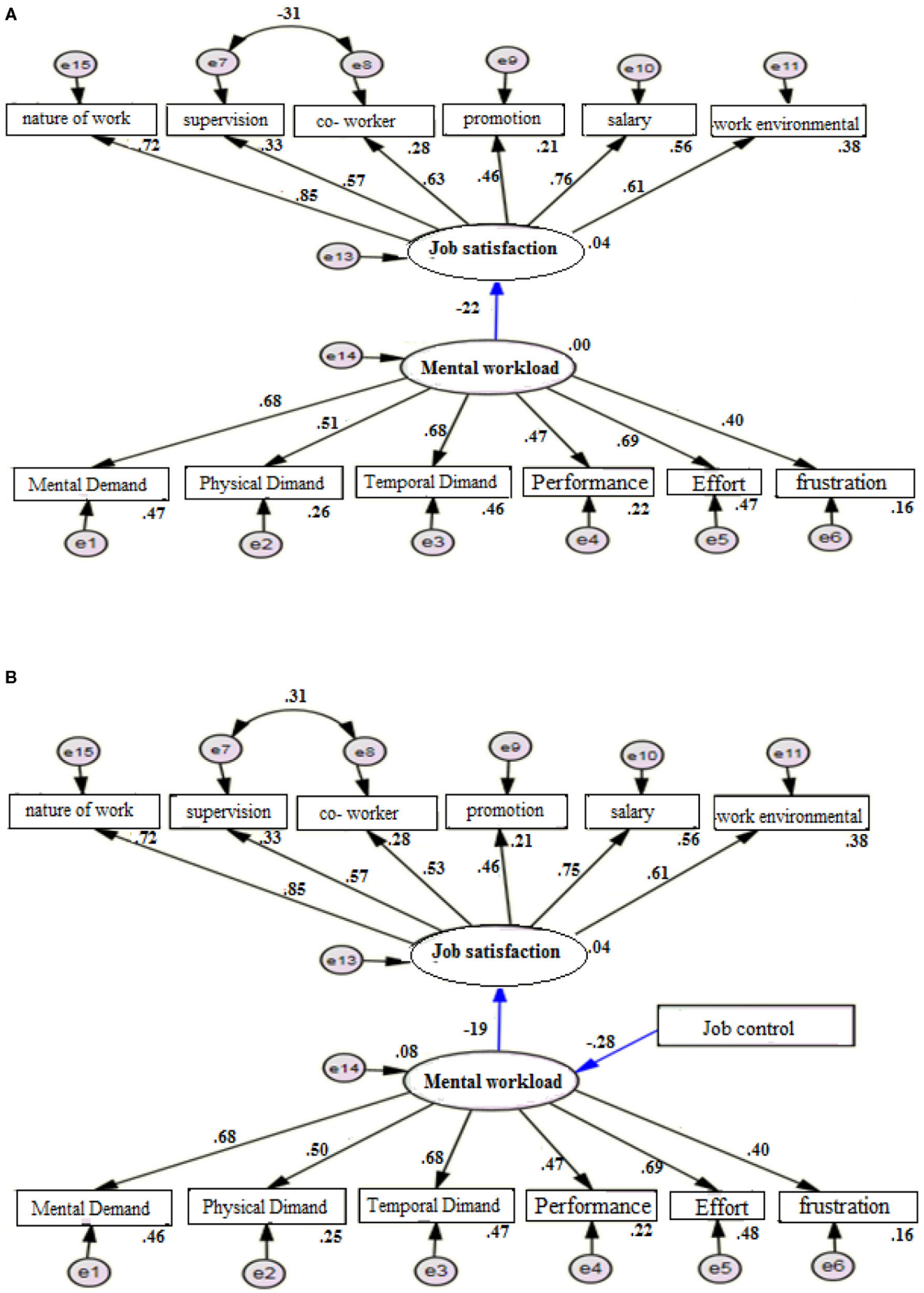

FIGURE 2 | (A) The model of relationship between job satisfaction and mental workload without job control moderating variables. **(B)** The model of relationship between job satisfaction and workload with moderating variable of job control.

TABLE 4 | Goodness criteria of model fit in relationship between mental workload, job satisfaction, and moderating variable of job control.

Goodness criteria of model fit	CFI[a]	RMSEA[b]	TLI[c]	CMIN/DF[d]	IFI[e]
Without the job control	0.916	0.071	0.893	3.435	0.916
Presence of job control	0.918	0.64	0.899	2.985	0.919
Acceptable level	>0.08	<0.08	>0.08	<5	>0.08

[a]*Comparative Fit Index,* [b]*Root Mean Square Error of Approximation,* [c]*Tucker-Lewis Index,* [d]*Chi- square/DF, and* [e]*Incremental fit index.*

The correlation between the workload and job satisfaction in the presence of the job control was separately investigated in the three job groups (**Figure 3**). In the designed models (2a−2c), the standard coefficient between the variables of workload and job satisfaction in the three groups of nursing, midwifery, and administrative workers were $r = -0.21$, $r = -0.15$, and $r = -0.05$, respectively ($p < 0.001$); while the standard coefficient of job control on the workload were $r = -0.23$, $r = -0.25$, and $r = -0.375$, respectively ($p < 0.001$). The goodness of fit index of the designed models for investigation of the relationship between workload and job satisfaction in the presence of the job control variable in the three job groups showed that the designed models have a good fit (**Table 5**).

DISCUSSION

The Present Situation of Mental Workload Job Satisfaction

In this study, the mean mental workload was high indicating that employees faced relatively high mental stress. The mean score of job satisfaction indicates the relative satisfaction of the individuals with conditions and work environment. Furthermore, the level of job control showed that the hospital workforce had a proper control in performing their duties. In consonance with the results, the level of mental workload in nurses was higher than in midwives and the administrative workers had the least level of workload. This trend is reversed for job satisfaction and job control, and the levels of job satisfaction and control among the administrative workers were higher than nurses and midwives. The activities demanding high concentration and attention create significantly great mental workload in the human operators to achieve a specific level of performance (42).

Other Studies have revealed a positive correlation between the job satisfaction and job performance of nurses and midwives (18, 19). The increase in work-hours is one of the causes of job dissatisfaction. It has a negative impact on the quality of services provided with the patient and decreases the patients' satisfaction with hospital services (20).

The level of job control between nurses and midwives was almost similar. The results indicated that by lowering the workload in the employees, more job satisfaction is observed, and they will have a better control over the assigned affairs. The difference in the amount of mental workload between nurses and midwives can be attributed to the work environment and more clients referred to nurses compared to midwives (6).

In addition, the clients, who referred to nurses, have predominantly acute and special situations and sometimes are overcrowded in the emergency department at the times of chain accidents and similar cases, which lead to more stress in nurses (40, 43). According to a study by Oliveira et al. nurses experienced a higher workload than other occupational groups, which was more related to poor working conditions and to a lack of job satisfaction (44). In a study conducted by Muhammadani et al. midwives were highly satisfied with organizational structure and rewards; while they were less satisfied with the work environment and job opportunities (45). In the study of Gouzou et al. the cause of low job satisfaction in nurses was related to rotational shifts in addition to workload (46).

Here, variables such as age and work experience had a significant relationship with mental workload. In the study of Wihardja et al., no significant relationship was observed between age, work experience, and mental workload of employees (47). They stated many other factors influence nurses in response to stimulation from their work. The length of working time can cause boredom and create job stress in person, however other factors inside or outside the nurse's capacity (48) also Studies showed psychological factors as one of risk factors in creating MSDs, in the initial phase of development, is important in workplaces (42).

In our study, job satisfaction in elderly healthcare workers was higher compared to younger people. The findings were consistent with the results studies of Carrillo-García et al. (49), and Alcaraz-Mor et al. (50). In the study of Singh et al., the most satisfied professionals were the youngest and the oldest (51); another study showed workers in the intermediate age range having the highest satisfaction levels (52). In this study, no significant relationship was found between age and work experience with job control. Since the job control is rooted in one's skill in doing the job and it can be independent of the individual age or work experience; thus, the job control is higher in the individuals with more skills.

The Relationship Between Mental Workload and Healthcare Workers Job Satisfaction

This study investigated the relationships between mental workload and job satisfaction of the healthcare workers and then, the mediating role of the job control variable in this relationship evaluated. The results showed that there was a significant and inverse correlation between mental workload and job satisfaction. The findings are in agreement with the results of previous studies (44, 46). However, in the study of Oscar

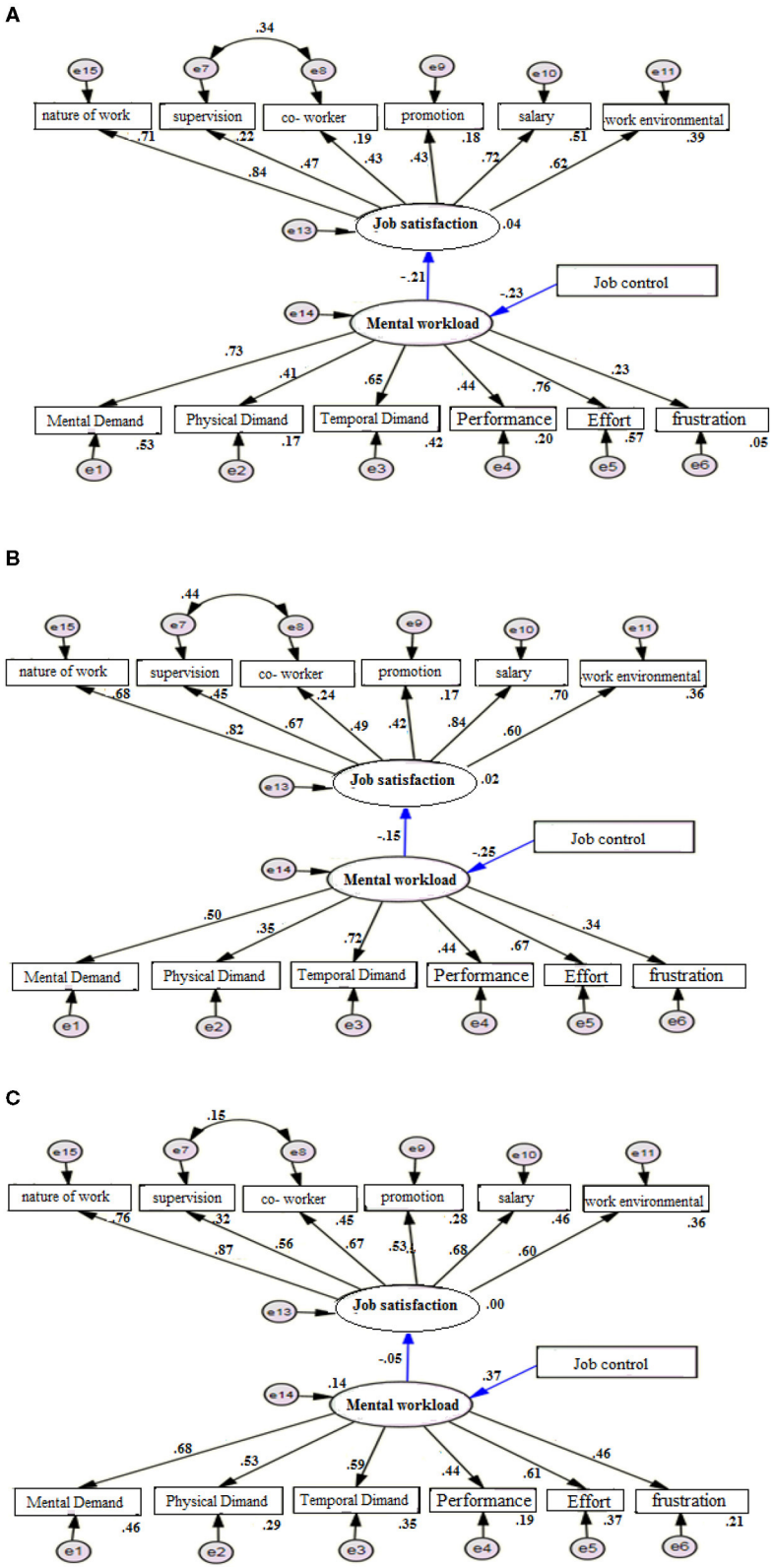

FIGURE 3 | The model of relationship between variables of divided occupational groups; **(A)** nurses, **(B)** midwives, and **(C)** administrative staff.

TABLE 5 | The relationship model between mental workload and job satisfaction by considering the job control variable by occupational groups.

Job	CMIN/DF	IFI	TLI	CFI	RMSEA	RMR
Nurse	1.646	0.923	0.902	0.921	0.059	0.030
Midwife	2.254	0.847	0.804	0.824	0.072	0.038
Administrative staff	2.186	0.846	0.804	0.824	0.078	0.044
Acceptable level	<5	>0.08	>0.08	>0.08	<0.08	<0.05

Measure	Threshold
Chi-square/df (cmin/df)	<3 good; <5 sometimes permissible
P-value for model	>0.05
CFI	>0.95 great; >0.90 traditional; >0.80 sometimes permissible
GFI	>0.95
AGFI	>0.80
SRMR	<0.09
RMSEA	<0.05 good; 0.05–0.10 moderate; >0.10 bad
PCLOSE	>0.05

et al. no correlation was found between job satisfaction and mental workload, stating that mental workload scores associated with the practice of telemedicine were high and remained stable over time (16). According to Goetz et al. there was not any correlations between physical activities and job satisfaction in general physicians, and job satisfaction had a significant relationship with health indicators (53). Job satisfaction leads to improving performance (6). In this regard, management can play an important role in creating a suitable environment in the workplace (18). Studies have shown that job satisfaction depends more on organizational factors than individual factors (11, 54). Organizational factors can improve the quality of work life of employees and be associated with job satisfaction (15, 54). The workload can lead to aspects of burnout, including emotional exhaustion and depersonalization in healthcare workers (22). In addition, it causes a feeling of personal failure and involvement in employees (24, 25). That is if individuals have more skills and more control over their responsibilities, then they will have a higher job satisfaction.

In the face of staff shortages among nurses, which are intensifying due to the aging of society, it is necessary to diagnose factors that increase the stressfulness of work, so that effective actions to counteract them can be taken. Particular attention should be paid to young people, with less work experience and better education, as they are the most susceptible to the psychosocial burden and leave the profession the most often (55). Workload and job satisfaction of healthcare workers also can be effective in providing appropriate services with patients (16). On the other hand, job dissatisfaction and lack of balance among workload, ability, and individual limitations may affect the public health (29).

As mentioned before, the designed model was a representative of a significant and negative correlation between mental workload and job satisfaction, and despite the job control, as a moderating variable, the relationship between the two variables of workload and job satisfaction increased. As the job control increases, mental workload of individuals was somehow moderated and the following job satisfaction was raised. Portoghese et al., investigated the moderating role of the job control in the relationship between workload and burnout among healthcare workers. The results indicate that a low job control can strengthen the positive and significant correlation between workload and burnout (31); which is consistent with our study. In the study of Adibi et al., the role of job control was observed in the relationship between positive and negative behaviors of employees (41). With respect to the demand-job control theory, the stress in work environments occurs for people when the level of job demands is high and in contrast, job control is low (32). In contrast, Martinussen et al. showed that job control beyond the job demand has a significant predictive power for burnout Therefore, job control as a potential moderator variable can play a good role in patterns such as demand-control-behavioral consequences (33).

Among the aspects of mental workload, the highest score was related to effort. Moreover, among the variables of job satisfaction, the highest score was related to the nature of work while the results of studies on nurses showed that the highest score among the workload aspects was related to the time pressure (56). The results of the other studies showed that the performance pressure was lower compared to the other aspects of workload (17). Taheri et al., showed that in addition to physical pressure, the nurses are subjected to other complications such as the pressure of time, a lack of control over the work pace, and psychological need that play an influential role in needle stick injuries (57). Based on the designed model, the relationship between the variables of mental workload and job satisfaction was more robust in nurses than in midwives and administrative workers. It can be due to the high level of mental workload and the variety of the nurses' responsibilities. However, the time pressure and mental workload were lower in administrative workers than

those in the treatment department, and consequently, this relationship was not much strong despite the desirability of the designed model.

Improving organizational support can represent a target for both managers and workers who want to mitigate the negative consequences of stress, both in economic and health terms (58).

LIMITATIONS

The study was performed using questionnaires, which can bias the results. Physicians did not participate in this study, although they can play a major role in hospital settings. Moreover, the study was restricted to the several state hospitals. Further research may look at the outcomes of private hospitals and compare them to the findings of this report.

CONCLUSION

The mental workload in healthcare was high and the results showed that job satisfaction diminished by an increase in mental workload. Job control can play an important role in improving the working conditions of healthcare workers and in increasing the job satisfaction. It is important to develop organizational management practices that enable job control; therefore, the management strategies should be adopted to diminish the workload pressure and increase the job control in order to enhance the job satisfaction among healthcare workers. In this regard, managers can temporarily reduce the workload by providing a supple program such as a floating workforce.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, with permission from Ethics Committee of SFMS.

AUTHOR CONTRIBUTIONS

MF-A and FR: study conception and design. AB-P and ZM: data collection. AJ and MF-A: analysis and interpretation of results. GT-B, FR, MF-A, and AB-P: draft manuscript preparation. All authors reviewed the results and approved the final version of the manuscript.

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REFERENCES

1. Ghahremani E, Parandeh A, Vafadar Z, Ebadi A. Survey of the occupational hazards and related factors in health care workers in military hospitals during 2016-2017. *J Mil Med*. (2018) 20:56–64. Available online at: http://militarymedj.ir/article-1-1817-fa.pdf
2. Aluko OO, Adebayo AE, Adebisi TF, Ewegbemi MK, Abidoye AT, Popoola BF. Knowledge, attitudes and perceptions of occupational hazards and safety practices in Nigerian healthcare workers. *BMC Res Notes*. (2016) 9:71 doi: 10.1186/s13104-016-1880-2
3. Mossburg S, Agore A, Nkimbeng M, Commodore-Mensah Y. Occupational hazards among healthcare workers in Africa: a systematic review. *Ann Glob Health*. (2019) 85:78. doi: 10.5334/aogh.2434
4. Menzel NN. Back pain prevalence in nursing personnel: measurement issues. *Aaohn J*. (2004) 52:54–65. doi: 10.1177/216507990405200204
5. Tung C-Y, Chang C-C, Ming J-L, Chao K-P. Occupational hazards education for nursing staff through web-based learning. *Int J Environ Res Public Health*. (2014) 11:13035–46. doi: 10.3390/ijerph111213035
6. Suzuki K, Ohida T, Kaneita Y, Yokoyama E, Miyake T, Harano S, et al. Mental health status, shift work, and occupational accidents among hospital nurses in Japan. *J Occup Health*. (2004) 46:448–54. doi: 10.1539/joh.46.448
7. Gallant-Roman MA. Strategies and tools to reduce workplace violence. *AAOHN J*. (2008) 56:449–54. doi: 10.1177/216507990805601102
8. Bloxsome D, Ireson D, Doleman G, Bayes S. Factors associated with midwives' job satisfaction and intention to stay in the profession: an integrative review. *J Clin Nurs*. (2019) 28:386–99. doi: 10.1111/jocn.14651
9. Bernal D, Campos-Serna J, Tobias A, Vargas-Prada S, Benavides FG, Serra C. Work-related psychosocial risk factors and musculoskeletal disorders in hospital nurses and nursing aides: a systematic review and meta-analysis. *Int J Nurs Stud*. (2015) 52:635–48. doi: 10.1016/j.ijnurstu.2014.11.003
10. Gyekye A, Salminen S. Making sense of industrial accidents: the role of job satisfaction. *J Soc Sci*. (2006) 2:127–34. doi: 10.3844/jssp.2006.127.134
11. Eskandari D, Jafari MJ, Mehrabi Y, Kian MP, Charkhand H, Mirghotbi M. A qualitative study on organizational factors affecting occupational accidents. *Iran J Public Health*. (2017) 46:380.
12. Dai B, Akey-Torku B, editors. The influence of managerial psychology on job satisfaction among healthcare employees in Ghana. *Healthcare*. (2020) 8:262 doi: 10.3390/healthcare8030262
13. Lee MS-M, Lee M-B, Liao S-C, Chiang F-T. Relationship between mental health and job satisfaction among employees in a medical center department of laboratory medicine. *J Formos Med Assoc*. (2009) 108:146–54. doi: 10.1016/S0929-6646(09)60045-0
14. Khamlub S, Harun-Or-Rashid M, Sarker MAB, Hirosawa T, Outavong P, Sakamoto J. Job satisfaction of health-care workers at health centers in Vientiane Capital and Bolikhamsai Province, Lao PDR. *Nagoya J Med Sci*. (2013) 75:233.
15. Lu Y, Hu X-M, Huang X-L, Zhuang X-D, Guo P, Feng L-F, et al. Job satisfaction and associated factors among healthcare staff: a cross-sectional study in Guangdong Province, China. *BMJ Open*. (2016) 6:e011388. doi: 10.1136/bmjopen-2016-011388
16. Boultinghouse OW, Hammack GG, Vo AH, Dittmar ML. Assessing physician job satisfaction and mental workload. *Telemed J E Health*. (2007) 13:715–8. doi: 10.1089/tmj.2007.0010
17. Rafiee N, Hajimaghsoudi M, Bahrami Ma, Ghasemi N, Mazrooei M. Evaluation nurses' mental work load in Emergency Department: case study. *J Nurs Manag*. (2015) 3:20–26. Available online at: http://ijnv.ir/article-1-245-en.html
18. Platis C, Reklitis P, Zimeras S. Relation between job satisfaction and job performance in healthcare services. *Proc Soc Behav Sci*. (2015) 175:7–480. doi: 10.1016/j.sbspro.2015.01.1226
19. Hadizadeh Talasaz Z, Nourani Saadoldin S, Taghi Shakeri M. The relationship between job satisfaction and job performance among midwives working in healthcare centers of Mashhad, Iran. *J Midwifery Reprod Health*. (2014) 2:64–157. doi: 10.22038/JMRH.2014.2623

20. Neamat Sotodeh Asl DAHB. Occupational exhaustion and its related factors in nurses and midwives of Semnan University of medical sciences. *J Kurdistan Univ Med Sci*. (2006) 11:77–83. Available online at: https://www.sid.ir/en/Journal/ViewPaper.aspx?ID=52915
21. Weinger MB, Reddy SB, Slagle JM. Multiple measures of anesthesia workload during teaching and nonteaching cases. *Anesth Analg*. (2004) 98:1419–25. doi: 10.1213/01.ANE.0000106838.66901.D2
22. Asgari H, Khalkhali H, Mohebbi I. Analytical survey on relation between workload with occupational burnout dimensions in ICU nurses. *J Urmia Nurs Midwifery Fac*. (2016) 14:30–8. Available online at: http://eprints.umsu.ac.ir/id/eprint/3812
23. Paneque RJ, Carvajal JRP. Occupational hazards and diseases among workers in emergency services: a literature review with special emphasis on Chile. *Medwave*. (2015) 15:1–9. doi: 10.5867/medwave.2015.07.6239
24. Wells J. The impact of stress amongst health professionals. *J Ment Health*. (2011) 20:111–4. doi: 10.3109/09638237.2011.556161
25. Kaur H, Malhotra N. General mental health issues in relation with job satisfaction among nurses. *J Community Psychol*. (2018) 14:54–9. Available online at: https://psycnet.apa.org/record/2018-14315-004
26. Caruso CC. Negative impacts of shiftwork and long work hours. *Rehabil Nurs*. (2014) 39:16–25 doi: 10.1002/rnj.107
27. Feiz-Arefi M, Rostami F, Jahangirimehr A, Babaei-Pouya A. Examining job satisfaction, mental workload, and job control in midwives working in hospital. *Pak J Med Health Sci*. (2020) 14:1780–4. Available online at: https://www.scopus.com/inward/record.uri?eid=2-s2
28. Fatehi F, Mohammadi M, Karimian M, Azmon M, Shahabi H, Gharibi F. Job Stress factors and their relationship with self-efficacy and public health nurses and midwives of Beast Hospital. *Shenakht J Psychol Pstchiatry*. (2015) 2:11–100. Available online at: http://paper.researchbib.com/view/paper/152461
29. Beheshti M, Hajizadeh R, Khodaparast E, Shojaei R, Ranjbar E. The role of workload and job satisfaction in general health of industrial workers in Gonabad, Iran, in 2015. *J Occup Health Epidemiol*. (2014) 3:17–25. doi: 10.18869/acadpub.johe.3.1.17
30. Leiter MP, Maslach C. Areas of worklife: a structured approach to organizational predictors of job burnout. *Emot Physiol Process Positive Interv Strat*. (2003) 3:91–34. doi: 10.1016/S1479-3555(03)03003-8
31. Portoghese I, Galletta M, Coppola RC, Finco G, Campagna M. Burnout and workload among health care workers: the moderating role of job control. *Safety Health Work*. (2014) 5:152–7. doi: 10.1016/j.shaw.2014.05.004
32. Chiang FF, Birtch TA, Kwan HK. The moderating roles of job control and work-life balance practices on employee stress in the hotel and catering industry. *Int J Hosp Manag*. (2010) 29:25–32. doi: 10.1016/j.ijhm.2009.04.005
33. Martinussen M, Richardsen AM, Burke RJ. Job demands, job resources, and burnout among police officers. *J Crim Justice*. (2007) 35:239–49. doi: 10.1016/j.jcrimjus.2007.03.001
34. Hart SG, Staveland LE. Development of NASA-TLX (Task Load Index): results of empirical and theoretical research. In: Hancock PA, Meshkati Neditors. *Human Mental Workload*. Amsterdam: North-Holland (1988). p. 139–83. doi: 10.1016/S0166-4115(08)62386-9
35. Stanton N, Hedge A, Brookhuis K, Salas E, Hendrick H. *Handbook of Human Factors and Ergonomics Methods*. New York, NY: CRC press (2005). p. 764. doi: 10.1201/9780203489925
36. Rubio S, Díaz E, Martin J, Puente JM. Evaluation of Subjective Mental workload: a comparison of SWAT, NASA-TLX, and workload profile methods. *Appl Psychol*. (2004) 53:61–86. doi: 10.1111/j.1464-0597.2004.00161.x
37. Mohammadi M, Mazloumi A, Nasl seraji J, Zeraati H. Designing questionnaire of assessing mental workload and determine its validity and reliability among ICUs nurses in one of the TUMS's hospitals. *J Sch Public Health Inst Public Health Res*. (2013) 11:87–96. Available online at: http://sjsph.tums.ac.ir/article-1-5043-en.html
38. Smith P, Kendall L, HuhnC. *The Measurement of Satisfaction in Work and Retirement*. Chicago, IL: Rand McNally (1969).
39. Zamanian Z, Roshan Sarvestani M, Sedaghati M, Ghatmiri M, Kouhnavard B. Assessment of the relation between subjective workload and job satisfaction in University faculty and staff. *J Ergonomics*. (2016) 3:1–10. Available online at: http://journal.iehfs.ir/article-1-217-en.html
40. Healy S, Tyrrell M. Stress in emergency departments: experiences of nurses and doctors. *Emerge Nurse*. (2011) 19:31–7. doi: 10.7748/en2011.07.19.4.31.c8611
41. Adibi Z, Golparvar M, Mosahebi MR. The moderating role of job control in relations between overload, ambiguity and role conflict with positive and negative behavioral outcomes. *Knowl Res Appl Psychol*. (2011) 12:54–65. Available online at: http://journals.khuisf.ac.ir/jsr-p/article-1-351-en.html
42. Darvishi E, Maleki A, Giahi O, Akbarzadeh A. Subjective mental workload and its correlation with musculoskeletal disorders in bank staff. *J Manipulat Physiol Ther*. (2016) 39:420–6. doi: 10.1016/j.jmpt.2016.05.003
43. Wu C, Ge Y, Xu C, Zhang X, Lang H. A correlation study of emergency department nurses' fatigue, perceived stress, social support and self-efficacy in grade III A hospitals of Xi'an. *Medicine*. (2020) 99:777–80. doi: 10.1097/MD.0000000000021052
44. Oliveira JFd, Santos AMd, Primo LS, Silva MRSd, Domingues ES, Moreira FP, et al. Job satisfaction and work overload among mental health nurses in the south of Brazil. *Ciencia Saude Coletiva*. (2019) 24:2593–9. doi: 10.1590/1413-81232018247.20252017
45. Muhammadani B. Job satisfaction of midwives working in labor ward of the Lady Dufferin Hospital: a cross-sectional study. *Age Int J Humanit Soc Sci*. (2015) 9:26–30. doi: 10.5281/zenodo.1109257
46. Gouzou M, Karanikola M, Lemonidou C, Papathanassoglou E, Giannakopoulou M. Measuring professional satisfaction and nursing workload among nursing staff at a Greek Coronary Care Unit. *Rev Esc Enferm USP*. (2015) 49:15–21. doi: 10.1590/S0080-62342015000000003
47. Wihardja H, Hariyati RTS, Gayatri D. Analysis of factors related to the mental workload of nurses during interaction through nursing care in the intensive care unit. *Enferm Clin*. (2019) 29:262–9. doi: 10.1016/j.enfcli.2019.06.002
48. Zhan Y, Ma S, Jian X, Cao Y, Zhan X. The current situation and influencing factors of job stress among frontline nurses assisting in Wuhan in fighting COVID-19. *Front Public Health*. (2020) 8:579866. doi: 10.3389/fpubh.2020.579866
49. Carrillo-García C, Solano-Ruíz MdC, Martínez-Roche ME, Gómez-García CI. Job satisfaction among health care workers: the role of gender and age. Rev. *Latino Am Enfermagem*. (2013) 21:1314–20. doi: 10.1590/0104-1169.3224.2369
50. Alcaraz-Mor R, Vigouroux A, Urcun A, Boyer L, Villa A, Lehucher-Michel M. Quality of work life of young hospital doctors Satisfied despite everything. *Int J Equity Health*. (2019) 31:113. doi: 10.3917/spub.191.0113
51. Singh T, Kaur M, Verma M, Kumar R. Job satisfaction among health care providers: A cross-sectional study in public health facilities of Punjab, India. *J Family Med Prim Care*. (2019) 8:3268. doi: 10.4103/jfmpc.jfmpc_600_19
52. López Layos MP, Torrejón Mora G, Martín Marcos A, Martín Morcillo J, Pleite Gómez F, Torres Alaminos MA. Estrés y satisfacción laboral de las enfermeras de hospitales toledanos. *Metas enferm*. (2011) 14:8–14.
53. Goetz K, Musselmann B, Szecsenyi J, Joos S. The influence of workload and health behavior on job satisfaction of general practitioners. *Fam Med*. (2013) 45:95–101.
54. Anin EK, Ofori I, Okyere S. Factors affecting job satisfaction of employees in the construction supply chain in the Ashanti region of Ghana. *Eur J Manag Bus Econ*. (2015) 7:222–839. Available online at: https://www.iiste.org/Journals/index.php/EJBM/article/view/20301
55. Kowalczuk K, Krajewska-Kułak E, Sobolewski M. Factors determining work arduousness levels among nurses: using the example of surgical medical treatment and emergency wards. *Biomed Res Int*. (2019) 2019:6303474. doi: 10.1155/2019/6303474
56. Zakerian SA, Abbasinia M, Mohammadian F, Fathi A, Rahmani A, Ahmadnezhad I, et al. The relationship between workload and quality of life

among hospital staffs. *J Ergonomics*. (2013) 1:43–56. Available online at: http://journal.iehfs.ir/article-1-25-en.html
57. Taheri MR, Khorvash F, Hassanzadeh A, Mahdavi Rad M. Assess the mental workload and its relationship with needle stick injuries among hospital staff nurses Al Zahra. *Med J Mashhad Univ Med Sci*. (2016) 58:70–577. Available online at: http://mjms.mums.ac.ir/article_6765.html
58. Lecca LI, Finstad GL, Traversini V, Lulli LG, Gualco B, Taddei G. The role of job support as a target for the management of work-related stress: the state of art. *Qual. Access Success.* (2020) 21:152–8.

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REVIEW
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Mitigating Burnout in an Oncological Unit: A Scoping Review

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Objectives: The purpose of this study was to provide a scoping review on how to address and mitigate burnout in the profession of clinical oncology. Also, it examines how artificial intelligence (AI) can mitigate burnout in oncology.

Methods: We searched Ovid Medline, PubMed, Scopus, and Web of Science, for articles that examine how to address burnout in oncology.

Results: A total of 17 studies were found to examine how burnout in oncology can be mitigated. These interventions were either targeted at individuals (oncologists) or organizations where the oncologists work. The organizational interventions include educational (psychosocial and mindfulness-based course), art therapies and entertainment, team-based training, group meetings, motivational package and reward, effective leadership and policy change, and staff support. The individual interventions include equipping the oncologists with adequate training that include—communication skills, well-being and stress management, burnout education, financial independence, relaxation, self-efficacy, resilience, hobby adoption, and work-life balance for the oncologists. Similarly, AI is thought to be poised to offer the potential to mitigate burnout in oncology by enhancing the productivity and performance of the oncologists, reduce the workload and provide job satisfaction, and foster teamwork between the caregivers of patients with cancer.

Discussion: Burnout is common among oncologists and can be elicited from different types of situations encountered in the process of caring for patients with cancer. Therefore, for these interventions to achieve the touted benefits, combinatorial strategies that combine other interventions may be viable for mitigating burnout in oncology. With the potential of AI to mitigate burnout, it is important for healthcare providers to facilitate its use in daily clinical practices.

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Conclusion: These combinatorial interventions can ensure job satisfaction, a supportive working environment, job retention for oncologists, and improved patient care. These interventions could be integrated systematically into routine cancer care for a positive impact on quality care, patient satisfaction, the overall success of the oncological ward, and the health organizations at large.

Keywords: burnout—professional, mitigate, compassion fatigue, address, job satisfaction, oncology, artificial intelligence, stress

INTRODUCTION

The oncologists are confronted with important decisions daily due to their dealings with patients with cancer (1). This makes this specialty inherently challenging as cancer is capable of inflicting devastation on the life of the person diagnosed with it. The individuals diagnosed with cancer usually experience psychological trauma, overwhelming emotions, and social and economic burden due to the effects of this deadly disease (2). As a result, oncologists are often exposed to long hours of direct patient care (3), medical counseling of the families of the patients, cumbersome electronic documentation, ever-changing medical environments, feeling of loss of control over daily responsibilities, and dissatisfaction in the provided resources by the health facilities to deal with emotional reactions of patients and their families (4, 5).

Despite the significant advances in the field of oncology, many patients with cancer still face long-suffering and die of the disease. This constantly exposes oncologists to difficult feelings of grief and compassion fatigue. At the same time, they have to use their cognitive and intellectual capacities to administer complex treatments to patients who are seriously ill. These aforementioned factors make them vulnerable to burnout syndrome (5). Following the first time that the term was described by psychologist Herbert Freudenberger, several attempts have been made to properly put this phenomenon into perspective (6–9). For instance, the WHO considered burnout as a syndrome that includes feelings of energy depletion, job dissatisfaction, and reduced professional performance (10). Likewise, it was construed as a form of chronic job stress that is characterized by three principal constructs, which include emotional exhaustion, cynicism and depersonalization, and reduced personal and professional efficacy (7, 11). Although, later definitions have eschewed personal and professional accomplishment as it was found that it overlaps with individual traits such as self-efficacy (12). Other forms of burnout manifestations include physical exhaustion, frequent oncology-related ethical mistakes, ineffectiveness, decreasing professional competence, unexplainable mood swing and absenteeism, and a sense of detachment toward colleagues and patients (13–15).

The challenge of burnout in oncology has a mean prevalence of 70% in Europe (16) and varies between 20 and 70% around the world (17, 18). Additionally, it is a multifaceted phenomenon with negative impacts on oncologists, colleagues, patients, and healthcare institutions (19). For oncologists, it affects personal well-being and increases the possibility of medical errors (17, 18). Consequently, these have profound effects on the patients as it affects their adherence to treatment recommendations and reduces the overall satisfaction of the medical care provided (20–23). Furthermore, these negative consequences underscore the long-term success of healthcare establishments (5, 24, 25).

In the absence of adequate well-being of oncologists, there is a significant chance for the oncologists to leave in search of a more conducive working environment or decrease the working hours (26, 27). Similarly, an increasing number of chemical dependence [alcoholism, drug addiction, and cigarette smoking (15)], and frequent disagreement between colleagues have been reported among oncologists (28). Also, the recent increase in suicide rates among junior doctors suggests the need to properly examine the issue of burnout in healthcare facilities (29). These observations are pointers that a holistic approach is important to understand the well-being of oncologists. Of note, in the current economic situation due to the COVID-19 pandemic, many institutions will have to deal with a decrease in staff numbers and other resources. It is expected that work may become increasingly stressful which may lead to burnout.

Therefore, understanding how to address oncologist burnout may offer an insightful step toward improving the quality of care offered to patients with cancer. As a result of this, we aim to conduct a scoping review of the published articles to identify the evidence-based approaches that focused on how to address and mitigate burnout in the oncology medical profession. Furthermore, we identify and analyze how artificial intelligence (AI) can assist to mitigate burnout in this field. The aforementioned research questions are important to map the current state of research in this subject area (oncology) when planning future research. Burnout in oncology was specifically considered as oncologists have been touted to be frequently affected by burnout syndrome and thus becoming one of the most vulnerable professionals (4, 30).

MATERIALS AND METHODS

Search Protocol

In this study, we systematically retrieved all studies that addressed burnout in oncology. The systematic search included databases of Ovid Medline, PubMed, Scopus, and Web of Science from inception until the end of July 2021. The framework that informed the search strategy was guided by the population (participants), concept, and context framework (PCC) (31). With the PCC paradigm, the questions of "who," "what," and "with what qualifiers" questions were answered. That is, the

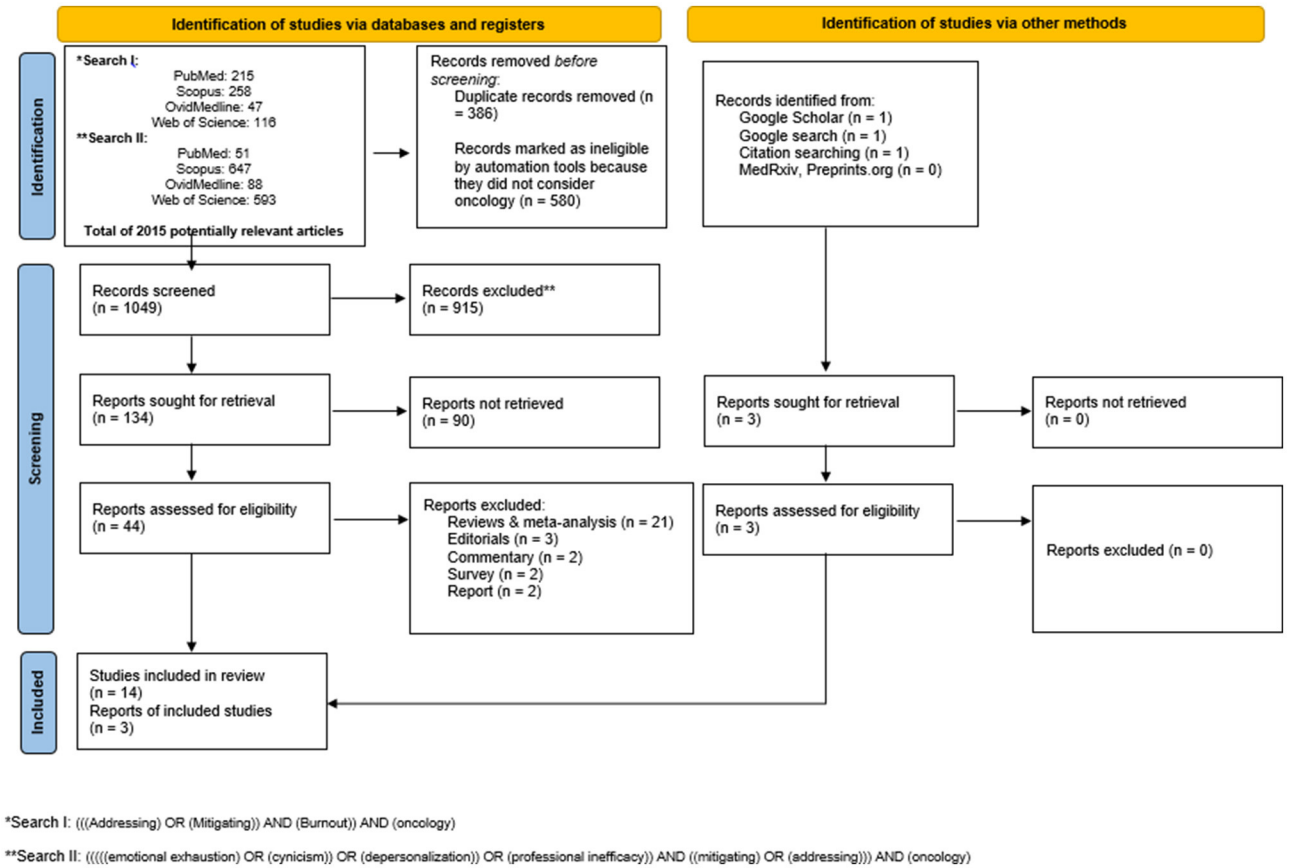

FIGURE 1 | The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flow diagram highlighting the search strategy and the search results.

population (who: oncologists), concept (what: burnout), and context (what qualifiers: mitigate burnout) paradigm was used to formulate the research questions. Thus, the search approach was developed by combining search keywords: [("addressing AND burnout AND oncology") OR ("mitigating AND burnout AND oncology")]. The search terms were extended to consider other related terms such as [("emotional exhaustion" OR "cynicism" OR "depersonalization" OR "professional inefficacy" AND "mitigating" AND "oncology")]. The search term extension was necessary to capture all possible studies. The retrieved hits were further analyzed for possible duplicates and irrelevant studies. Also, to further minimize the omission of any study, the reference lists of all the eligible articles were manually searched to ensure that all the relevant studies were duly included. In addition, experts were contacted and a Google search (Google Scholar) for relevant articles or PhD theses relating to this scoping review was done. To avoid selection bias due to selective publication, and most importantly, to enrich the scoping review process and reduce research waste, unpublished studies were also considered. The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) was used in the searching and screening processes (**Figure 1**).

Inclusion and Exclusion Criteria

All studies that had examined how to address or mitigate burnout in oncology were included in this study. However, studies that considered ways of mitigating or addressing burnout among radiation therapists, physician assistants, medical assistants, graduate medical trainees, radiologists, physicians, nurses, infusion center professionals, and nursing oncology were excluded. Additionally, studies that considered burnout interventions in other fields such as social sciences, psychology, environmental science, biochemistry, genetics, molecular biology, neuroscience, doctors, pharmacology, toxicology, and pharmaceutical; arts and humanities, business, management, and accounting were excluded. Similarly, to further enhance the quality of this study, comments, opinions, perspectives, editorials, reviews, abstracts only, and articles in languages other than English were excluded (**Figure 1**). As this study was aimed at a scoping review, a meta-analysis of the included studies was not performed.

Screening

The screening was done in two distinct stages. In the first stage, two independent reviewers (RA and OY) used a data extraction sheet to examine the titles and abstracts of the

TABLE 1 | The main findings from the included studies.

References/type of study	Location	Title of the study	Size of participants (methodology)	Population	Main findings	Summary of mitigating burnout
Le Blanc et al. (32)/original study	Netherlands	Take care! The evaluation of a team-based burnout intervention program for oncology care providers	• 664 participants (Questionnaire)	Oncologists	• Less depersonalization and emotional exhaustion were observed in wards where the burnout interventions were introduced • Burnout level is significantly related to job perception (meaningful job)	• Team focused participatory training intervention program (e.g., management support such as six sessions/month at 3 h for each session)
Italia et al. (15)/pilot study	Italy	Evaluation and art therapy treatment of the burnout syndrome in oncology units	• 65 participants (Maslach Burnout Inventory)	• Doctors and nurses (Group A) • Pediatric Oncology residents (Group B)	• The art intervention showed reduced level of burnout in Group B	• Recommendation of art treatment therapies
Bar-Sela et al. (3)/original study	Israel	"Balint group" meetings for oncology residents as a tool to improve therapeutic communication skills and reduce burnout level	• 17 participants (Prospective)	• Oncology residents	• Decrease in the incidence of burnout was observed	• Intervention method such as the Balint group meetings (for communication skills and strengthening doctor-patient relationships)
Moody et al. (33)/pilot study	United States and Israel	Helping the helpers: mindfulness for burnout in pediatric oncology- a pilot program	• 48 participants (Prospective)	• Pediatric Oncology	• The mindfulness-based course did not result in significant improvement in burnout, perceived stress, and depression	• Intervention program such as mindfulness-based course (MBC) could be useful for staff without burnout at baseline
Mukherjee et al. (34)/original study	United Kingdom	Staff burnout in pediatric oncology: new tools to facilitate the development and evaluation of effective interventions	• 32 participants (Interviews and surveys)	• Pediatric Oncology	• Two scales were created to facilitate the development and evaluation of effective intervention	• Interventions such as staff support, stress management and well-being interventions. • Evidence-based intervention such as Work Stressors Scale—Pediatric Oncology (WSS-PO) and Work Rewards Scale—Pediatric Oncology (WRS-PO)
Rasmussen et al. (35)/original study	Australia, United States, Netherlands, United Kingdom, Canada and Switzerland	Burnout among psychosocial oncologists: an application and extension of the effort-reward imbalance model	• 417 participants (Questionnaire)	• Psychosocial oncologists	• Higher effort and lower reward were significantly associated with greater emotional exhaustion, and not depersonalization • Overcommitment is strongly associated with both emotional exhaustion and depersonalization • Effort Reward Imbalance is partially supported for investigating burnout • Meaningful work is negatively related to emotional exhaustion and depersonalization	• Increasing self-efficacy • Positive changes to the oncological work environment • Increased rewards (money, praise, prize, better career opportunities) to the oncologists

(Continued)

TABLE 1 | Continued

References/type of study	Location	Tittle of the study	Size of participants (methodology)	Population	Main findings	Summary of mitigating burnout
He et al. (36)/original study	China	Dual role as a protective factor for burnout-related depersonalization in oncologists	• 131 (single role) and 168 (dual role) participants (Questionnaire)	• Oncologists (single role vs. dual role oncologists)	• Dual role oncologists (oncologists + psychosocial experience) showed less susceptibility to depersonalization, work-family conflict, and decision authority • Higher effort reward imbalance (ERI) predicted higher depersonalization in both dual role and single role oncologists • Overcommitment strongly associated with emotional exhaustion • Higher decision authority was associated with decreased emotional exhaustion • Work and Meaning inventory (meaningful work) is associated with decreased risk of depersonalization	• Psychosocial orientation to reduce depersonalization
Kavalieratos et al. (37)/original study	United States	"It is like heart failure It is chronic…and it will you": A qualitative analysis of burnout among hospice and palliative care clinicians	• 20 participants (Interview)	• Palliative care clinicians	Identified source of burnout include: • Increasing workload, tension between staff, regulatory issues • Variations between type of clinician and practice setting	• Individual (self-regulation, protective strategies, and protective strategies) solution • Interpersonal solution • Organizational change (change to working culture [frequent rotations on-and-off service], policy that encourages self-care of the staff, and regulation) solution.
Vetter et al. (38)/original study	United States	Resilience, hope and flourishing are inversely associated with burnout among members of the society for gynecologic oncology	• 374 gynecologic oncology	• Oncology	• Resilience • Hope	• Resilience, hope, flourishing and well-being metrics are inversely proportional to burnout • Male oncologists had higher level of hope, resilience, and well-being • Marital status is also an important factor
Richardson et al. (39)/original study	United States	Development of an "art of oncology" curriculum to mitigate burnout and foster solidarity among hematology/oncology fellows	• 16 participants (Prospective) • 26 fellows in total	• Oncologists • Fellows in Hematology-Oncology	• 93% respondents believed art of oncology (AOO) curriculum can address burnout • Work-life balance is associated with burnout • AOO can enhance solidarity among oncologists and fellow hematology-oncology	• Art of Oncology (AOO) curriculum

(Continued)

TABLE 1 | Continued

References/type of study	Location	Title of the study	Size of participants (methodology)	Population	Main findings	Summary of mitigating burnout
Kaimal et al. (40)/pilot study	United States	Outcomes of art therapy and coloring for professional and informal caregivers of patients in a radiation oncology unit: a mixed methods pilot study	• 34 participants (Prospective)	• Oncologists • Family caregivers	• Increase in Self-efficacy • Decrease in anxiety, perceived stress, and burnout	• Art therapy e.g., coloring or open studio art therapy (a 45-min session each) • Dedicated open studio space in oncological unit with art-making available
Weintraub et al. (41)/original study	United States	A cross-sectional analysis of compassion fatigue, burnout and compassion satisfaction in pediatric hematology-oncology physicians in the United States	• 363 participants (Survey)	• Hematology-Oncology	Higher Burnout: • Compassion Fatigue • Administrative burden • Co-workers Lower Burnout: • Compassion satisfaction • Socializing Higher compassion satisfaction: • Exercise • Socializing • Talking with partners Lower compassion satisfaction: • Compassion Fatigue • Burnout • Emotional depletion • Administrative work • Inconvenient working environment	• Professional development in leadership • Communication • Conflict resolution • Team building and connectedness • Self-care
Royce et al. (42)/original study	United States	A burnout reduction and wellness strategy: personal financial health for the medical trainee and early career radiation oncologist	• NA	• Radiation oncologists	• Financial independent training	• The financial independent training can assist in improved quality of life for the oncologists through understanding student loans, debt management plan and independent of employment income
LeNoble et al. (43)/original study	United States	To address burnout in oncology, we must look to teams: reflections on an organizational science approach	• 409 participants (Prospective)	• Oncologists and Oncology provider	• Team-focused intervention led to higher level of team work and reduced levels of burnout. • It encouraged communication (interprofessional relationships), improved well-being and psychological safety • It positively affected the delivery of cancer care	• Team-focused burnout intervention approach
Turner et al. (44)/pilot	United States	The society of gynecologic oncology wellness curriculum pilot: A groundbreaking initiative for fellowship training	• 73 participants (Prospective)	• Oncology (Gynecologic)	• After the curriculum, the percentage of fellows that are comfortable to discuss wellness topic increased from 63 to 74%. Prior to the curriculum, 75% felt that they could identify symptoms of burnout or psychosocial distress.	• A structured curriculum aimed at promoting wellness amongst gynecology is imperative

(Continued)

TABLE 1 | Continued

References/type of study	Location	Title of the study	Size of participants (methodology)	Population	Main findings	Summary of mitigating burnout
Abusanad et al. (45)/original study	Saudi Arabia, Egypt, Sudan, Algeria, United Arab Emirates, Morocco, Yemen, Oman, Iraq, Syria, Lebanon, and Jordan	Burnout in oncology: Magnitude, risk factors and screening among professionals from Middle East and North Africa (BOMENA study)	• 1,054 participants (Prospective)	• Medical oncologists	• Hobby practicing • Oncology communication • Appreciate oncology work-life balance	• Having burnout skill, education, and support was found important to address burnout
Mascaro et al. (46)/original study	United States	Feasibility, Acceptability, and Preliminary Effectiveness of a Compassion-centered Team Intervention to Improve Clinical Research Coordinator Resilience and Well-being	• NA	• Oncologists (Clinical research coordinators)	• Compassion- centered, Team-based intervention Compassion-Centered Spiritual Health Team Intervention [CCSH-TI]	• The proposed team intervention may offer feasible, credible, and acceptable approach to providing resilience to oncology clinical research coordinators.

Prospective, The study observes for outcomes of the effect of the introduction of certain interventions on some participants.
NA, Not available.

TABLE 2 | Summary of quality assessment.

References	AHRQ score	Quality interpretation
Le Blanc et al. (32)	8	High
Italia et al. (15)	7	Medium
Bar-Sela et al. (3)	7	Medium
Moody et al. (33)	7	Medium
Mukherjee et al. (34)	8	High
Rasmussen et al. (35)	8	High
He et al. (36)	8	High
Kavalieratos et al. (37)	6	Medium
Vetter et al. (38)	8	High
Richardson et al. (39)	9	High
Kaimal et al. (40)	7	Medium
Weintraub et al. (41)	7	Medium
Royce et al. (42)	4	Medium
LeNoble et al. (43)	6	Medium
Turner et al. (44)	8	High
Abusanad et al. (45)	7	Medium
Mascaro et al. (46)	7	Medium

retrieved and potentially relevant articles. The data extraction sheet was used to minimize the omission of possible eligible studies. The interobserver reliability was measured using Cohen's Kappa coefficient ($\kappa = 0.83$). In the second stage, possible discrepancies regarding the studies considered relevant were resolved by a consensus meeting and discussion between the two independent reviewers. The relevant information regarding the study characteristics of each of these potentially relevant articles was extracted (summarized in **Table 1**).

Quality Appraisal

The preliminary quality appraisal was done using the quality guideline for systematic review as recommended by the National Institute of Health Quality Assessment tools (47). The included studies in this review were subjected to four quality criteria informed by a similar study that used the same quality assessment tool (48). These criteria were modified to include design, methodology, interventions, and statistical analysis (**Supplementary Table 1**). The studies that showed reasonable quality (≥50%) were further subjected to the main quality assessment using the Agency for Health Research and Quality (AHRQ) tool. The AHRQ quality assessment tool was chosen as this scoping review aims at identifying means of burnout mitigation in oncology. The AHRQ has a total of 11 items for the methodological quality assessment (**Supplementary Table 1**) (49). The AHRQ has been scaled with score 0 for "NO" and "Unclear" and score 1 for "Yes." An overall score of >8 indicated a "high" quality. Conversely, an AHRQ score between four and seven was defined as "medium" while a score of <4 was defined as "low" quality (49, 50). The score disagreements were resolved by consensus discussion between the two independent reviewers (RA and OY). The result of the quality assessment is presented in **Table 2**.

Data Extraction

In each eligible study, the name of the first author, year of publication, country, the title of studies, results of the interventions, and summary of the strategies to address burnout in oncology were extracted (**Table 1**). A detailed explanation of the strategic interventions to mitigating burnout in oncology was discussed collectively in the discussion section.

RESULTS

Results of the Database Search

The selection of eligible studies for this study is presented with the PRISMA flowchart (**Figure 1**). A total of 2015 hits were retrieved. After deleting duplicates ($N = 386$), irrelevant papers ($N = 580$), and exclusions ($N = 915$), we found 17 studies eligible to be included in this scoping review as shown in **Figure 1** (3, 15, 32–46).

Characteristics of Relevant Studies

All the articles included were published in the English language. Of the 17 included studies, 9 (52.9%) studies were conducted only in the United States (37–44, 46), 3 (17.6%) studies carried out in Europe (15, 32, 34), 2 (11.8%) studies each from Asia (3, 36), and 3 (17.6%) studies were from the international multicenter (33, 35, 45). From the included studies, 6 (35.3%) studies recommended individual interventions (how to address burnout) that include self-efficacy, self-regulation, and protective strategies for the oncologists (35–38, 41, 45). Furthermore, in addition to the individual intervention, 12 (70.5%) studies suggested organizational interventions that include organizing team-based participatory training such as group meetings, staff support, review policies, positive changes to the working environment, leadership and communication skills training for the staff, stress management, psychosocial education (mindfulness-based course, career development, resiliency training, and conflict resolution), motivational and encouragement (reward, prizes, and appreciation of efforts), and art treatment therapies (3, 15, 32–37, 39, 43, 44, 46) (summarized in **Table 1**). In terms of the quality assessment of the included studies, 7 (41.2%) of the included studies showed high-quality assessment scores. Conversely, 10 (58.8%) of the included studies were of medium-quality scores study (**Table 2**).

Summary of the Findings From the Studies

The findings of these studies (summarized in **Table 1**) indicated that burnout is a substantial issue associated with oncology as a medical profession. The included articles contained several recommendations of interventions that could serve as the impetus for addressing and mitigating burnout in the oncological ward. These interventions were broadly categorized into seven divisions: individual, organizational, educational, art and entertainment, team-based, motivational, and disruptive technology. The risk factors found for the prevalence, expression, and manifestations of burnout in the oncological unit are presented in **Figure 2** (Box 1).

The results also indicated that these interventions are poised to offer self-care, personal well-being (less depersonalization

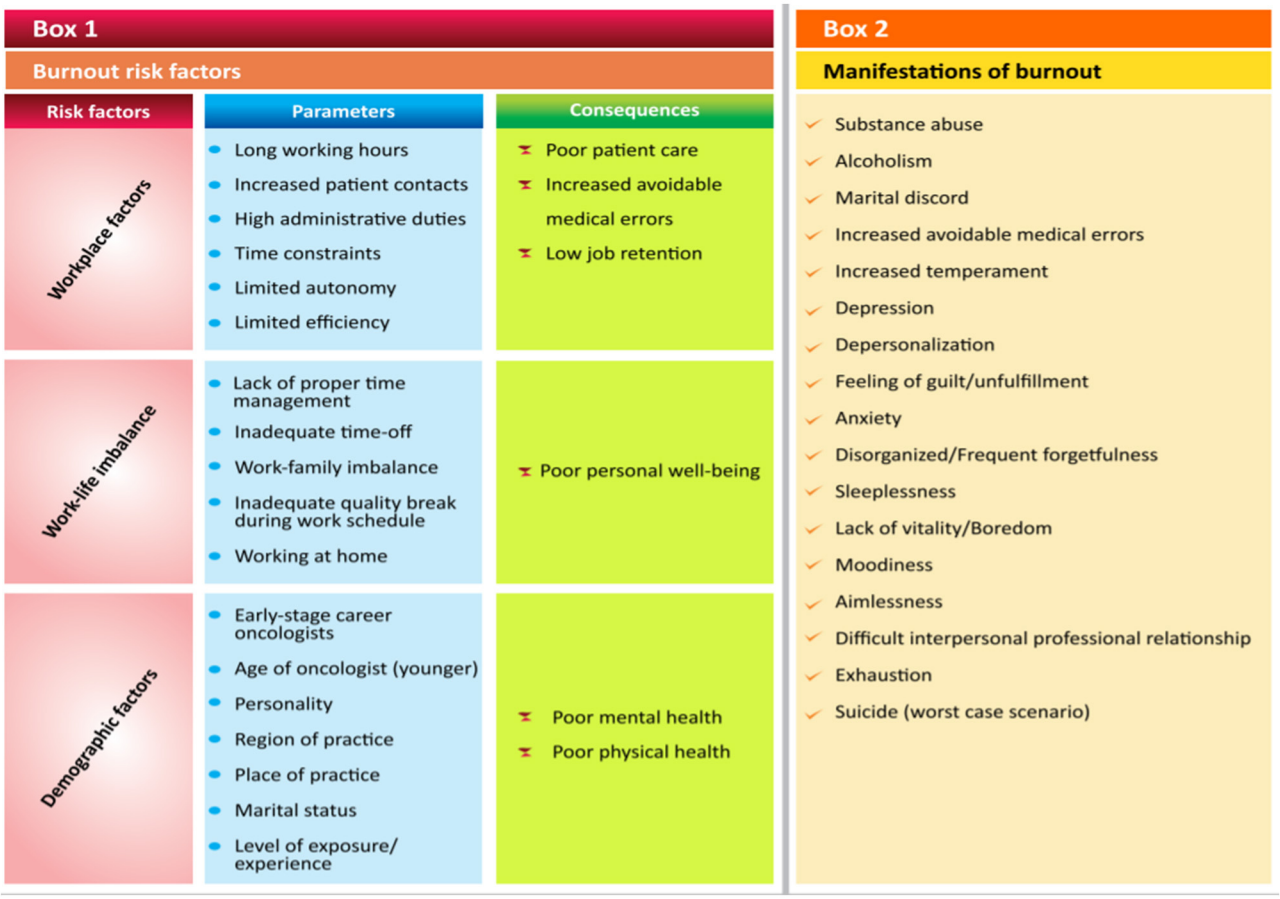

FIGURE 2 | The prevalence, expression, and manifestations of burnout in the oncological unit.

and emotional exhaustion), resilience and reduction to burnout, and job satisfaction and retention for the oncologists (3, 15, 32, 36, 39, 43). It was found that the burnout level is strongly associated with job satisfaction (32, 34). Considering the effort-reward imbalance model, higher efforts and a lower reward were reported to be associated with emotional exhaustion (35) and depersonalization (36). Meanwhile, overcommitment is strongly linked to both emotional exhaustion and depersonalization (35, 36). Having trained in psychosocial education was found to show a higher impact on work-family balance and reduce depersonalization (36). Similarly, creating a conducive working environment for meaningful work was associated with decreased risk of depersonalization (36).

DISCUSSION

In this scoping review, we examined the published studies on how to address or mitigate burnout in oncology as a medical profession. In terms of prevalence, specifically in the United States, it was reported that around 62% of the oncologists have reported experiencing specific symptoms of this burdensome phenomenon called burnout. In Europe and Australia, it varies significantly, ranging from 52 to 78% (5). Thus, without proper measures to address and mitigate burnout in oncology, the pool of available resources for proper cancer management may not achieve the desired objectives due to stress, depression, burnout, and tragically even suicide among the oncologists.

The stressor that causes burnout can be generic, work-related stressors such as monotonous, wearisome and unexciting tasks, significant workload, and poor interpersonal relationships with colleagues (34). In addition, excessive interruptions, meaningless documentation and regulatory specifications, cumbersome electronic health record (EHR) systems, and increasing pressure on the oncologists to attend to more patients without consideration on quality and oncologists-patients relationships are posited to putting the oncologists in morally compromising situations (51). Thus, increasing the possibility of stress and burnout (51). Also, there are job-specific stressors that are inherent to each job such as oncology (34, 52). An example of such stressors includes administering and managing complex treatment regimens for patients with cancer. Several work-related stressors in oncological settings have been published

(27, 32, 53). Overcommitment has also posed as an individual stressor that is capable of causing emotional exhaustion and depersonalization which may eventually lead to burnout (35, 36).

Therefore, from the aforementioned, it becomes a shared responsibility between the oncologists and the organizations where they work to be determined in their approach toward reducing burnout and further cultivate resilience and career satisfaction (5, 54–56). This means that effective interventions that are poised to address and mitigate burnout may require that it is multifaceted, i.e., addressing organizational and personnel stressors that lead to burnout (33, 57). That is, individual oncologists are expected to identify burnout in themselves and their colleagues (5, 58). Similarly, organizations should be ready to offer systematic interventions (5, 58, 59).

Individual interventions for oncologists include self-efficacy, self-regulation, and protective strategies against stress and burnout (35–37, 41). However, the lack of confidentiality, stigmatization, and the trepidation of professional repercussions are some of the factors affecting medical staff such as the oncologists from help-seeking attempts on challenges such as behavioral health issues (burnout, depression, and suicide) (60). Therefore, the need for an inflection point to transparent and appropriate help-seeking behavior from the oncologists to address behavioral health issues such as burnout becomes imperative (60). To this end, the organization should provide the necessary help-seeking platforms and staff support (including psychological and bereavement support, working hours limitation, resiliency training, and team role clarifications) to avoid burnout (34).

Furthermore, it is important for organizations to carefully and critically develop an evidence-based and appropriate type of training for medical team leaders (24). It has been reported that good leadership skills and qualities are capable of reducing burnout, increases staff well-being, and position the organization in which they function for success (24). Also, the cordial relationship between the staff and their team leader or supervisor is a critical aspect of professional satisfaction (61). Therefore, the leadership types, skills, and qualities have a significant impact on well-being, degree of burnout, and professional satisfaction (24). The organizational factors that impact well-being include the nature of the practice environment (work-life balance), the level of autonomy offered to the staff, and the amount of workload assigned to the staff (54–56, 62). These interventions can replete oncologists and offset their emotional exhaustion (33).

Team-based interaction and group meetings improve communication skills, keep the team members informed, engage them through sharing ideas for improvements in their practice environments, discussions about career development, and provides constructive feedback to team members (24). Likewise, organizational interventions in the form of education, training, and short-term courses such as stress management, psychosocial education, mindfulness-based course, and conflict-resolution training. However, the level of stress and burnout within the oncological unit should be accessed before the introduction of any course or training for optimum results (33, 34). Similarly, the courses and training should be carefully structured to avoid adding another stress to the already busy professional schedule of the oncologists (33).

The use of context-specific measures to access work-related stressors and rewards as the reliance on generic measures may provide an incomplete picture of the level of stress among staff (34, 52). Thereby, this might lead to a recommendation of inappropriate burnout interventions. An example of the widely used measure is the effort-reward imbalance model. Of note, effort corresponds to the obligations and responsibilities that the employee is saddled with, while the rewards are not necessarily financial but may include esteem (respect), prizes and awards, job well-done appreciation, job security, and career opportunities and progression (34, 35). Thus, higher efforts and lower reward are strongly associated with emotional exhaustion (35) and both emotional exhaustion and depersonalization (36). Though, overcommitment predicts both emotional exhaustion and depersonalization. This is because, overcommitted individuals have a set of attitudes, behaviors, and emotions that make them strive to be approved (35, 63). To this end, they are usually prone to stress and burnout (35, 64).

It has been reported that the use of art treatment therapies in the form of coloring, dedicated open art studio with therapeutic support within the oncological unit, psychodrama, and relaxation increase the oncologist in self-care and decreases anxiety, perceived stress, and burnout in both oncologist and family caregivers (15, 40). Interestingly, participants with interest (or experience) in art-making were found to benefit more from this intervention (40). The motive behind the art-making intervention is to shift the attention of the stressed personnel away from their worries (40). Therefore, this brings to mind that various interventions should be offered on a personal level. This is because people benefit from different types of these interventions.

Although burnout and stress shared almost similar symptomatology, they are however different concepts. While stress is short-term and disappears once the situation becomes conducive, burnout is a long-term and complex phenomenon that gradually develops over an extended period of time (9, 65). Of note, untreated and unaddressed burnout may lead to personal chronic health consequences such as heart disease, stroke, obesity, or mental health consequences such as depressions, anxiety, substance and chemical use, and suicide (1, 66–71). Professionally, it may lead to reduced professional accomplishment and satisfaction (1, 66). Other closely related concepts (but with overlapping features) such as compassion fatigue, moral distress, and empathy fatigue captured different aspects of burnout (5). In general, this study provides background information for further research in this field, especially in surgical oncology.

Artificial Intelligence as an Intervention to Mitigate Burnout in Oncology

With advancements in technology, the application of AI in medicine continues to grow significantly. In terms of mitigating burnout, AI is thought to be poised to offer a potential to

mitigate burnout in oncology by enhancing the productivity and performance of the oncologists, reduce the workload and provide job satisfaction, and foster teamwork between the caregivers of patients with cancer (72).

There are arrays of studies that have been published regarding the potential of machine learning and AI for the prognostication of cancer which suggested that the performance and productivity of oncologists can be improved (72). For example, the prediction of recurrences and overall survival (73–75). Thus, AI technology such as deep learning is poised to enhance precision medicine (76–79) and improved clinical decisions (73, 74). With the improved clinical decisions, the oncologists may experience emotional satisfaction, reduced depersonalization, and increased professional efficacy. Hence, the it offers the potential to increase job satisfaction and reduce burnout of oncologists (80, 81).

In addition, the high workload has been reported as an important factor that contributes to occupational stress (82, 83). This has a negative effect on the quality of care offered to the patients. It has been reported that administrative tasks contribute to the workload of clinicians and significantly limit the time for direct clinical face time between the clinicians and patients (84). For example, it was found that physicians spend 49% of their work time on administrative tasks (desk work and EHRs) and 33% of their work time on direct clinicians-patient interaction (84). Thus, AI has been touted to significantly reduce this administrative burden (72).

Natural language processing, a branch of AI offers the potential for detailed and informative summarization of EHRs. It offers cognitive systems that can interpret, augment, and transform free text contained in the EHR and clinical notes in a format that can be represented for computation (85). This might be an instrument to reduce the workload and stress for the oncologists in terms of the onerous tasks of navigating and engagement with the EHR. With the aid of natural language processing, the structured data fields can be autopopulated from the notes of clinicians (72). Similarly, it can assist in the proper querying of relevant data of patients and transcribe past patient encounters. For example, it was reported that transcription (voice-to-text) can enhance work time savings of 17% for doctors (72).

Finally, the use of AI may aid through the optimized billing codes, and quality outcome reporting for hospital records and regulatory purposes (85). It also has the potential to integrate unstructured and structured data from different sources (72). This provides more cohesive, faster, and convenient access to information of patients across the multidisciplinary team in the oncological unit. This can greatly foster teamwork, easy collaboration, strong communication for shared decision making, and coordinated actions on the evaluation of the progress of the patients by the caregivers of patients with cancer (72). Therefore, the aforementioned benefits of AI intervention have the potential to further reduce workload and create a relaxed working environment for the oncologist and thus avoid stress. With these AI-based interventions, the oncologists may be well-positioned to perform with greater efficiency, engagement, and effectiveness (85).

CONCLUSION

In conclusion, many oncological wards would have to deal with increasing admission of patients with cancer. This might be even more emphasized due to the recent outbreak of coronavirus pandemic. It is expected that work will become increasingly stressful and the possibility of burnout remains high. Therefore, healthcare management should recognize and seek to address this problem in oncology. Finding ways to ameliorate burnout is important for creating a conducive working environment for oncologists and to increase the well-being of oncologists and reduce medical errors. The interventions presented in this study will not achieve the required touted objectives without recognition of burnout as a problem by the healthcare institutions and professional bodies. This ensures that individual interventions are considered important, and consequently combinatorial strategies that include other interventions presented in this study offer the most viable hope to mitigating burnout among oncologists and positively affect the delivery of cancer care.

Clinical Implications

The physical and emotional well-being of the clinical oncologists is important to enhance the quality of care, patient satisfaction, and overall success of the organizations where the oncologists work (5). The physical and mental distress resulting from burnout adversely affects clinical oncologists-patients relationships (51), poorer patient outcomes (40), increases inefficacy, errors, chronic health conditions, and decreased productivity of the clinical oncologists (5, 51). Consequently, their personal engagements outside work such as family life and lifestyles are usually affected (5, 13). Due to the increasing prevalence of burnout in oncology, some of the oncologists have tragically left their practice or retired early (after decades of specialized training) (86, 87) or even committed suicide in some cases (60). Thereby, an increasing shortage of oncologists is evident. Based on these implications, the oncologists need to recognize the stress and burnout symptoms, acquire mindfulness training, learn resilience and cognitive-behavioral psychotherapy skills, reiterate their professional objectives, and improve communications and interpersonal skills to ensure the quality of care offered to the patients. The burnout interventions listed in this study are targeted at effective wellness strategies for the clinical oncologists and to improve their professional environment.

Strength and Limitations

Strengths of this study include: (a) a systematic scoping review of all the published studies that have examined burnout intervention in clinical oncology. It maps the current state of research in this subject area (oncology medical profession) and aids in future planning of research; (b) these interventions were broadly categorized into seven divisions, namely, individual, organizational, educational, team-based, art and entertainment, motivational, and disruptive technology; and (c) furthermore, the possibility of disruptive technology such as AI and its subfield, machine learning as a possible intervention for addressing

burnout in a medical profession was examined. There are certain limitations relating to this scoping review. First, the quality assessment score of all the included studies was not significantly high. Additionally, there are a few concerns about some of the interventions mentioned in the articles included in this study. Most of these interventions were thought of as those that were targeted at either oncologists (individuals) or the organization. Rarely were the interventions aimed at targeting both the oncologists and the organizations (88). Considering interventions (how to address burnout) that target both individuals and organizations may be pertinent for an effective burnout reduction strategy. Of note, it is important to include more participants (oncologists) in the evaluation of the benefits of these interventions to evaluate their efficacy. Moreover, some of these interventions require significant evidence-based support and strategies needed for institutions to introduce them to their organizational structures. Thus, it is important to avoid generalizing the reviewed interventions. Also, some challenges must be addressed by policymakers, healthcare providers, industry, and patients before AI can safely be used in an oncological unit.

AUTHOR CONTRIBUTIONS

RA and AM: study concepts and study design. RA and OY: studies extraction. PH and AA: acquisition and quality control of included studies. RA, ME, AA, AM, and PH: data analysis and interpretation. RA, OY, AA, AM, and PH: manuscript preparation. AA, ME, and PH: manuscript review. AA, RA, and OY: manuscript editing. All authors approved the final manuscript for submission.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.677915/full#supplementary-material

REFERENCES

1. Shanafelt T, Dyrbye L. Oncologist burnout: causes, consequences, and responses. *J Clin Oncol Off J Am Soc Clin Oncol.* (2012) 30:1235–41. doi: 10.1200/JCO.2011.39.7380
2. Jaiswal A. *Integrative Bioinformatics of Functional and Genomic Profiles for Cancer Systems Medicine*, Finland: University of Helsinki (2018). p. 82.
3. Bar-Sela G, Lulav-Grinwald D, Mitnik I. "Balint group" meetings for oncology residents as a tool to improve therapeutic communication skills and reduce burnout level. *J Cancer Educ.* (2012) 27:786–9. doi: 10.1007/s13187-012-0407-3
4. Copur MS. Burnout in Oncology. *Oncology*. (Williston Park). (2019) 33:687522.
5. Hlubocky FJ, Back AL, Shanafelt TD. Addressing burnout in oncology: why cancer care clinicians are at risk, what individuals can do, and how organizations can respond. *Am Soc Clin Oncol Educ Book Am Soc Clin Oncol Annu Meet.* (2016) 35:271–9. doi: 10.1200/EDBK_156120
6. Freudenberger HJ. Staff burn-out. *J Soc Issues.* (1974) 30:159–65. doi: 10.1111/j.1540-4560.1974.tb00706.x
7. Maslach C, Jackson S, Leiter M. *Maslach Burnout Inventory Manual*. 3rd ed. Palo Alto, CA: Consulting Psychologists Press (1996).
8. National Academy of Medicine. *Validated Instruments to Assess Work-Related Dimensions of Well-Being*. (2020). Available online at: https://nam.edu/valid-reliable-survey-instruments-measure-burnout-well-work-related-dimensions/ (accessed April 30, 2020).
9. Bährer-Kohler S. *Burnout for Experts*. Boston, MA: Springer US (2013). doi: 10.1007/978-1-4614-4391-9
10. World Health Organization. *ICD-11 for Mortality and Morbidity Statistics, QD85 Burn-out. International Classification of Disease*. (2019). Available online at: https://icd.who.int/browse11/l-m/en#/http://id.who.int/icd/entity/129180281 (accessed April 30, 2020).
11. Chopra SS. Physician burnout. *J Am Med Assoc.* (2004) 291:633. doi: 10.1001/jama.291.5.633
12. Demerouti E, Bakker AB, Nachreiner F, Schaufeli WB. A model of burnout and life satisfaction amongst nurses. *J Adv Nurs.* (2000) 32:454–64. doi: 10.1046/j.1365-2648.2000.01496.x
13. Spickard A, Gabbe SG, Christensen JF. Mid-career burnout in generalist and specialist physicians. *J Am Med Assoc.* (2002) 288:1447–50. doi: 10.1001/jama.288.12.1447
14. Meier DE, Back AL, Morrison RS. The inner life of physicians and care of the seriously ill. *J Am Med Assoc.* (2001) 286:3007–14. doi: 10.1001/jama.286.23.3007
15. Italia SC, Favara-Scacco A, Di Cataldo A, Russo G. Evaluation and art therapy treatment of the burnout syndrome in oncology units. *Psychooncology.* (2008) 17:676–80. doi: 10.1002/pon.1293
16. Banerjee S, Califano R, Corral J, de Azambuja E, De Mattos-Arruda L, Guarneri V, et al. Professional burnout in European young oncologists: results of the European Society for Medical Oncology (ESMO) Young Oncologists Committee Burnout Survey. *Ann Oncol Off J Eur Soc Med Oncol.* (2017) 28:1590–6. doi: 10.1093/annonc/mdx196
17. Murali K, Makker V, Lynch J, Banerjee S. From burnout to resilence: an update for oncologists. *Am Soc Clin Oncol Educ Book*. (2018) 38:862–72. doi: 10.1200/EDBK_201023
18. Murali K, Banerjee S. Burnout in oncologists is a serious issue: what can we do about it? *Cancer Treat Rev.* (2018) 68:55–61. doi: 10.1016/j.ctrv.2018.05.009
19. van Wyk BE, Pillay-Van Wyk V. Preventive staff-support interventions for health workers. In: The Cochrane Collaboration, editors, *Cochrane Database Syst. Rev*. Chichester: John Wiley & Sons, Ltd (2010). doi: 10.1002/14651858.CD003541.pub2
20. Shanafelt TD, Balch CM, Bechamps G, Russell T, Dyrbye L, Satele D, et al. Burnout and medical errors among American surgeons. *Ann Surg.* (2010) 251:995–1000. doi: 10.1097/SLA.0b013e3181bfdab3
21. West CP, Dyrbye LN, Erwin PJ, Shanafelt TD. Interventions to prevent and reduce physician burnout: a systematic review and meta-analysis. *Lancet.* (2016) 388:2272–81. doi: 10.1016/S0140-6736(16)31279-X
22. Haas JS, Cook EF, Puopolo AL, Burstin HR, Cleary PD, Brennan TA. Is the professional satisfaction of general internists associated with patient satisfaction? *J Gen Intern Med.* (2000) 15:122–8. doi: 10.1046/j.1525-1497.2000.02219.x
23. Girgis A, Hansen V, Goldstein D. Are Australian oncology health professionals burning out? A view from the trenches. *Eur J Cancer.* (2009) 45:393–9. doi: 10.1016/j.ejca.2008.09.029
24. Shanafelt TD, Gorringe G, Menaker R, Storz KA, Reeves D, Buskirk SJ, et al. Impact of organizational leadership on physician burnout and satisfaction. *Mayo Clin Proc.* (2015) 90:432–40. doi: 10.1016/j.mayocp.2015.01.012
25. Chiu SF, Tsai MC. Relationships among burnout, job involvement, and organizational citizenship behavior. *J Psychol.* (2006) 140:517–30. doi: 10.3200/JRLP.140.6.517-530

26. Grunfeld E, Whelan TJ, Zitzelsberger L, Willan AR, Montesanto B, Evans WK. Cancer care workers in Ontario: prevalence of burnout, job stress and job satisfaction. *CMAJ Can Med Assoc J J Assoc Medicale Can.* (2000) 163:166–9.
27. Ramirez AJ, Graham J, Richards MA, Cull A, Gregory WM, Leaning MS, et al. Burnout and psychiatric disorder among cancer clinicians. *Br J Cancer.* (1995) 71:1263–9. doi: 10.1038/bjc.1995.244
28. Creagan ET. Stress among medical oncologists: the phenomenon of burnout and a call to action. *Mayo Clin Proc.* (1993) 68:614–5. doi: 10.1016/S0025-6196(12)60378-4
29. Verghis S. *Wounded Healers*. (2018). Available online at: http://sharonverghis.com/stories/doctorsSuicide.html (accessed April 30, 2020).
30. Ramirez A, Graham J, Richards M, Timothy A. Stress at work for the clinical oncologist. *Clin Oncol.* (1996) 8:137–9. doi: 10.1016/S0936-6555(96)80036-7
31. University of South Australia. *Apply Population, Concept, and Context (PCC). What PCC.* (2021). Available online at: https://guides.library.unisa.edu.au/ScopingReviews (accessed August 24, 2021).
32. Le Blanc PM, Hox JJ, Schaufeli WB, Taris TW, Peeters MCW. Take care! The evaluation of a team-based burnout intervention program for oncology care providers. *J Appl Psychol.* (2007) 92:213–27. doi: 10.1037/0021-9010.92.1.213
33. Moody K, Kramer D, Santizo RO, Magro L, Wyshogrod D, Ambrosio J, et al. Helping the helpers: mindfulness training for burnout in pediatric oncology—a pilot program. *J Pediatr Oncol Nurs.* (2013) 30:275–84. doi: 10.1177/1043454213504497
34. Mukherjee S, Beresford B, Tennant A. Staff burnout in paediatric oncology: new tools to facilitate the development and evaluation of effective interventions. *Eur J Cancer Care.* (2014) 23:450–61. doi: 10.1111/ecc.12176
35. Rasmussen V, Turnell A, Butow P, Juraskova I, Kirsten L, Wiener L, et al. IPOS Research Committee, Burnout among psychosocial oncologists: an application and extension of the effort-reward imbalance model. *Psychooncology.* (2016) 25:194–202. doi: 10.1002/pon.3902
36. He Y, Pang Y, Zhang Y, Fielding R, Tang L. Dual role as a protective factor for burnout-related depersonalization in oncologists. *Psychooncology.* (2017) 26:1080–6. doi: 10.1002/pon.4425
37. Kavalieratos D, Siconolfi DE, Steinhauser KE, Bull J, Arnold RM, Swetz KM, et al. "It is like heart failure. it is chronic … and it will kill you": a qualitative analysis of burnout among hospice and palliative care clinicians. *J Pain Symptom Manage.* (2017) 53:901–10.e1. doi: 10.1016/j.jpainsymman.2016.12.337
38. Vetter MH, Vetter MK, Fowler J. Resilience, hope and flourishing are inversely associated with burnout among members of the Society for Gynecologic Oncology. *Gynecol Oncol Rep.* (2018) 25:52–5. doi: 10.1016/j.gore.2018.06.002
39. Richardson DR, Tan X, Winzelberg G, Rosenstein DL, Collichio FA. Development of an art of oncology curriculum to mitigate burnout and foster solidarity among hematology/oncology fellows. *JCO Oncol Pract.* (2020) 16:e384–94. doi: 10.1200/JOP.19.00529
40. Kaimal G, Carroll-Haskins K, Mensinger JL, Dieterich-Hartwell RM, Manders E, Levin WP. Outcomes of art therapy and coloring for professional and informal caregivers of patients in a radiation oncology unit: a mixed methods pilot study. *Eur J Oncol Nurs.* (2019) 42:153–61. doi: 10.1016/j.ejon.2019.08.006
41. Weintraub AS, Sarosi A, Goldberg E, Waldman ED. A cross-sectional analysis of compassion fatigue, burnout, and compassion satisfaction in pediatric hematology-oncology physicians in the United States. *J Pediatr Hematol Oncol.* (2020) 42:e50–5. doi: 10.1097/MPH.0000000000001548
42. Royce TJ, Davenport KT, Dahle JM. A burnout reduction and wellness strategy: personal financial health for the medical trainee and early career radiation oncologist. *Pract Radiat Oncol.* (2019) 9:231–8. doi: 10.1016/j.prro.2019.02.015
43. LeNoble CA, Pegram R, Shuffler ML, Fuqua T, Wiper DW. To address burnout in oncology, we must look to teams: reflections on an organizational science approach. *JCO Oncol Pract.* (2020) 16:e377–83. doi: 10.1200/JOP.19.00631
44. Turner TB, Kushner DM, Winkel AF, McGwin G, Blank SV, Fowler JM, et al. The Society of Gynecologic Oncology wellness curriculum pilot: a groundbreaking initiative for fellowship training. *Gynecol Oncol.* (2020) 156:710–4. doi: 10.1016/j.ygyno.2019.12.005
45. Abusanad A, Bensalem A, Shash E, Mula-Hussain L, Benbrahim Z, Khatib S, et al. Burnout in oncology: magnitude, risk factors and screening among professionals from Middle East and North Africa (BOMENA study). *Psychooncology.* (2021) 30:736–46. doi: 10.1002/pon.5624
46. Mascaro JS, Palmer PK, Ash MJ, Peacock C, Sharma A, Escoffery C, et al. Feasibility, acceptability, and preliminary effectiveness of a compassion-centered team intervention to improve clinical research coordinator resilience and well-being. *JCO Oncol Pract.* (2021) 17:e936–46. doi: 10.1200/OP.21.00120
47. National Institute of Health. *Study quality assessment tools, United States*. (2020). Available online at: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools (accessed May 13, 2020).
48. Phillips CS, Becker H. Systematic Review: expressive arts interventions to address psychosocial stress in healthcare workers. *J Adv Nurs.* (2019) 75:2285–98. doi: 10.1111/jan.14043
49. Rostom A, Dubé C, Cranney A, Saloojee N, Sy R, Garritty C, et al. Celiac disease. *Evid Rep Technol Assess.* Jun (2004) 104:1–6.
50. Xie W, Wang J, Zhang Y, Zuo M, Kang H, Tang P, et al. The levels, prevalence and related factors of compassion fatigue among oncology nurses: a systematic review and meta-analysis. *J Clin Nurs.* (2021) 30:615–32. doi: 10.1111/jocn.15565
51. Hlubocky FJ, Rose M, Epstein RM. Mastering resilience in oncology: learn to thrive in the face of burnout. *Am Soc Clin Oncol Educ Book Am Soc Clin Oncol Annu Meet.* (2017) 37:771–81. doi: 10.1200/EDBK_173874
52. Demerouti E, Bakker AB. The job demands–resources model: challenges for future research. *SA J Ind Psychol.* (2011) 37:974. doi: 10.4102/sajip.v37i2.974
53. Shanafelt TD, Novotny P, Johnson ME, Zhao X, Steensma DP, Lacy MQ, et al. The well-being and personal wellness promotion strategies of medical oncologists in the north central cancer treatment group. *Oncology.* (2005) 68:23–32. doi: 10.1159/000084519
54. Shanafelt TD, Sloan JA, Habermann TM. The well-being of physicians. *Am J Med.* (2003) 114:513–9. doi: 10.1016/S0002-9343(03)00117-7
55. Shanafelt TD. Enhancing meaning in work: a prescription for preventing physician burnout and promoting patient-centered care. *J Am Med Assoc.* (2009) 302:1338. doi: 10.1001/jama.2009.1385
56. Egener B, McDonald W, Rosof B, Gullen D. Perspective: organizational professionalism. *Acad Med.* (2012) 87:668–74. doi: 10.1097/ACM.0b013e31824d4b67
57. Cox T, Griffiths A, Barlowe C, Randall R, Rial-Gonzalez E. *Organisational Interventions for Work Stress: A Risk Management Approach*. Norwich: HSE Books (2020).
58. Hlubocky FJ, Taylor LP, Marron JM, Spence RA, McGinnis MM, Brown RF, et al. A call to action: ethics committee roundtable recommendations for addressing burnout and moral distress in oncology. *JCO Oncol Pract.* (2020) 16:191–9. doi: 10.1200/JOP.19.00806
59. Hlubocky FJ, Shanafelt TD, Back AL, Paice JA, Tetzlaff ED, Friese CR, et al. Creating a blueprint of well-being in oncology: an approach for addressing burnout from ASCO's clinician well-being taskforce. *Am Soc Clin Oncol Educ Book.* (2021) 2021:e339–53. doi: 10.1200/EDBK_320873
60. Nagy C, Schwabe D, Jones W, Brown A, Shupe M, Mancone A, et al. "Time to talk about it: physician depression and suicide" video/discussion session for interns, residents, and fellows. *J Teach Learn Resour.* (2016) 12:10508. doi: 10.15766/mep_2374-8265.10508
61. Demmy TL, Kivlahan C, Stone TT, Teague L, Sapienza P. Physicians' perceptions of institutional and leadership factors influencing their job satisfaction at one academic medical center. *Acad Med.* (2002) 77:1235–40. doi: 10.1097/00001888-200212000-00020
62. Wallace JE, Lemaire JB, Ghali WA. Physician wellness: a missing quality indicator. *Lancet.* (2009) 374:1714–21. doi: 10.1016/S0140-6736(09)61424-0
63. van Vegchel N, de Jonge J, Meijer T, Hamers JPH. Different effort constructs and effort-reward imbalance: effects on employee well-being in ancillary health care workers. *J Adv Nurs.* (2001) 34:128–36. doi: 10.1046/j.1365-2648.2001.3411726.x
64. Bakker AB, Killmer CH, Siegrist J, Schaufeli WB. Effort-reward imbalance and burnout among nurses. *J Adv Nurs.* (2000) 31:884–91. doi: 10.1046/j.1365-2648.2000.01361.x
65. Schaufeli WB, Leiter MP, Maslach C. Burnout: 35 years of research and practice. *Career Dev Int.* (2009) 14:204–20. doi: 10.1108/13620430910966406

66. Shanafelt TD, Raymond M, Kosty M, Satele D, Horn L, Pippen J, et al. Satisfaction with work-life balance and the career and retirement plans of US oncologists. *J Clin Oncol.* (2014) 32:1127–35. doi: 10.1200/JCO.2013.53.4560
67. Alarcon G, Eschleman KJ, Bowling NA. Relationships between personality variables and burnout: a meta-analysis. *Work Stress.* (2009) 23:244–63. doi: 10.1080/02678370903282600
68. Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. *Ann Intern Med.* (2002) 136:358. doi: 10.7326/0003-4819-136-5-200203050-00008
69. Shanafelt TD. Special report: suicidal ideation among American surgeons. *Arch Surg.* (2011) 146:54. doi: 10.1001/archsurg.2010.292
70. Oreskovich MR, Shanafelt T, Dyrbye LN, Tan L, Sotile W, Satele D, et al. The prevalence of substance use disorders in American physicians: the prevalence of substance use disorders in American. *Am J Addict.* (2015) 24:30–8. doi: 10.1111/ajad.12173
71. Tyssen R, Hem E, Vaglum PN, Grønvold T, Ekeberg Ø. The process of suicidal planning among medical doctors: predictors in a longitudinal Norwegian sample. *J Affect Disord.* (2004) 80:191–8. doi: 10.1016/S0165-0327(03)00091-0
72. Hazarika I. Artificial intelligence: opportunities and implications for the health workforce. *Int Health.* (2020) 12:241–5. doi: 10.1093/inthealth/ihaa007
73. Alabi RO, Elmusrati M, Sawazaki-Calone I, Kowalski LP, Haglund C, Coletta RD, et al. Machine learning application for prediction of locoregional recurrences in early oral tongue cancer: a Web-based prognostic tool. *Virchows Arch.* (2019) 475:489–97. doi: 10.1007/s00428-019-02642-5
74. Alabi RO, Elmusrati M, Sawazaki-Calone I, Kowalski LP, Haglund C, Coletta RD, et al. Comparison of supervised machine learning classification techniques in prediction of locoregional recurrences in early oral tongue cancer. *Int J Med Inf.* (2019) 2019:104068. doi: 10.1016/j.ijmedinf.2019.104068
75. Karadaghy OA, Shew M, New J, Bur AM. Development and assessment of a machine learning model to help predict survival among patients with oral squamous cell carcinoma. *J Am Med Assoc Otolaryngol Neck Surg.* (2019) 145:1115. doi: 10.1001/jamaoto.2019.0981
76. Fröhlich H, Balling R, Beerenwinkel N, Kohlbacher O, Kumar S, Lengauer T, et al. From hype to reality: data science enabling personalized medicine. *BMC Med.* (2018) 16:7. doi: 10.1186/s12916-018-1122-7
77. Shrager J, Tenenbaum JM. Rapid learning for precision oncology. *Nat Rev Clin Oncol.* (2014) 11:109–18. doi: 10.1038/nrclinonc.2013.244
78. J.-Bibault E, Giraud P, Burgun A. Big Data and machine learning in radiation oncology: state of the art and future prospects. *Cancer Lett.* (2016) 382:110–7. doi: 10.1016/j.canlet.2016.05.033
79. Ding MQ, Chen L, Cooper GF, Young JD, Lu X. Precision oncology beyond targeted therapy: combining omics data with machine learning matches the majority of cancer cells to effective therapeutics. *Mol Cancer Res.* (2018) 16:269–78. doi: 10.1158/1541-7786.MCR-17-0378
80. Zakhem GA, Motosko CC, Ho RS. How should artificial intelligence screen for skin cancer and deliver diagnostic predictions to patients? *J Am Med Assoc Dermatol.* (2018) 154:1383. doi: 10.1001/jamadermatol.2018.2714
81. Murali K, Banerjee S. Let's address burnout in oncologists and reimagine the way we work. *Nat Rev Clin Oncol.* (2019) 16:1–2. doi: 10.1038/s41571-018-0097-9
82. Marine A, Ruotsalainen JH, Serra C, Verbeek JH. Preventing occupational stress in healthcare workers. In: The Cochrane Collaboration, editors, *Cochrane Database Syst. Rev.* Chichester: John Wiley & Sons, Ltd (2006). doi: 10.1002/14651858.CD002892.pub2
83. Nieuwenhuijsen K, Bruinvels D, Frings-Dresen M. Psychosocial work environment and stress-related disorders, a systematic review. *Occup Med.* (2010) 60:277–86. doi: 10.1093/occmed/kqq081
84. Erickson SM, Rockwern B, Koltov M, McLean RM, Medical Practice and Quality Committee of the American College of Physicians. Putting patients first by reducing administrative tasks in health care: a position paper of the American College of Physicians. *Ann Intern Med.* (2017) 166:659. doi: 10.7326/M16-2697
85. Haddad TC. Artificial Intelligence as a solution to burnout in oncology. *Artif Intell Oncol Curr Appl Future Dir.* (2019). Available online at: https://www.cancernetwork.com/view/artificial-intelligence-oncology-current-applications-and-future-directions (accessed July 15, 2020).
86. Balch CM, Copeland E. Stress and burnout among surgical oncologists: a call for personal wellness and a supportive workplace environment. *Ann Surg Oncol.* (2007) 14:3029–32. doi: 10.1245/s10434-007-9588-0
87. Campbell DA, Sonnad SS, Eckhauser FE, Campbell KK, Greenfield LJ. Burnout among American surgeons. *Surgery.* (2001) 130:696–705. doi: 10.1067/msy.2001.116676
88. McFarland DC, Hlubocky F, Susaimanickam B, O'Hanlon R, Riba M. Addressing depression, burnout, and suicide in oncology physicians. *Am Soc Clin Oncol Educ Book Am Soc Clin Oncol Annu Meet.* (2019) 39:590–8. doi: 10.1200/EDBK_239087

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Subjective Symptoms in Magnetic Resonance Imaging Personnel: A Multi-Center Study in Italy

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Introduction: Magnetic Resonance Imaging (MRI) personnel have significant exposure to static and low-frequency time-varying magnetic fields. In these workers an increased prevalence of different subjective symptoms has been observed. The aim of our study was to investigate the prevalence of non-specific subjective symptoms and of "core symptoms" in a group of MRI personnel working in different centers in Italy, and of possible relationships with personal and occupational characteristics.

Methods: The occurrence of 11 subjective symptoms was evaluated using a specific questionnaire with 240 subjects working in 6 different Italian hospitals and research centers, 177 MRI health care and research personnel and 63 unexposed subjects employed in the same departments. Exposure was subjectively investigated according to the type of MRI scanner ($\leq$1.5 vs. $\geq$3 T) and to the number of MRI procedures attended and/or performed by the personnel, even if no information on how frequently the personnel entered the scanner room was collected. The possible associations among symptoms and estimated EMF exposure, the main characteristics of the population, and job stress perception were analyzed.

Results: Eighty-six percent of the personnel reported at least one symptom; drowsiness, headache, and sleep disorders were the most frequent. The total number of symptoms did not differ between exposed persons and controls. Considering the total number of annual MRI procedures reported by the personnel, no significant associations were found nor with the total number of symptoms, nor with "core symptoms." Only subjects complaining of drowsiness also reported a significantly higher mean annual number of MRI procedures with $\leq$ 1.5 T scanners when compared with exposed subjects without drowsiness. In a multivariate model, subjects with a high level of perceived stress complained of more symptoms ($p = 0.0002$).

Conclusions: Our study did not show any association between the occurrence of reversible subjective symptoms, including the more specific "core symptoms," and the occupational exposure of MRI personnel to static and low-frequency time-varying magnetic fields. On the other hand, the role played by occupational stress appears to be not negligible. In further research in this field, measurements of EMF exposure should be considered.

Keywords: magnetic resonance imaging, electromagnetic fields exposure, subjective symptoms, MRI operators, occupational health

INTRODUCTION

The number of Magnetic Resonance Imaging (MRI) scanners, and consequently the number of patients involved in MRI procedures and the personnel exposed to MRI-emitted electromagnetic fields (EMFs) have constantly increased since the early '90s in Europe and worldwide (1). The strength of the static magnetic flux density of the scanners currently used for diagnostic purposes is most commonly between 1 and 3 Tesla, though MRI scanners used for both clinical and research purposes can reach higher strengths (2, 3).

Considering occupational exposure, MRI personnel are potentially exposed to significant levels of static magnetic fields (SMFs), which are continuously active even when the scanner is not acquiring images, as they are associated with a powerful magnet. Moreover, workers within the SMF are also exposed to time-varying electric and magnetic fields when they perform movements close to the magnet. Contrary to patients, MRI personnel are usually not exposed to the radio-frequency (RF) EMFs generated by the scanner during the acquisition of diagnostic images, with a few possible exceptions when the personnel need to stay very close to patients and to the bore, as may sometimes happen, for example, in the case of pediatric or non-autonomous patients (4–7).

The risk related to occupational exposure to these types of EMFs needs to be evaluated, as it is for other occupational risks, in order to ensure adequate occupational safety and health (OSH) of MRI personnel (8). Among the effects to be considered for appropriate preventive interventions, it should be noted that, according to the scientific literature, various subjective sensory symptoms have been reported for MRI personnel (1, 9–15). These effects can be related to the mechanisms of current induction in electro-sensitive tissues of the human body by the SMFs and by the low frequency magnetic fields (4–6). Even though the majority of the reported symptoms are non-specific, a group of five "core symptoms" have been suggested: vertigo, nausea, head ringing, magnetophosphenes, and metallic taste (12). On the other hand, a number of more general symptoms have often been reported, such as headache and concentration problems, unusual drowsiness or tiredness, balance problems, and others (1, 9–15). Even though all these effects seem rapidly reversible when EMF exposure of MRI personnel is interrupted, their prevention is relevant because of the possibility of a higher risk of accidents leading to injury, especially after work-shift exposure (16, 17). There are also various experimental observations of minor and reversible alterations in performance, balance, and cognitive tests in groups of volunteers (9, 10, 18–23), also confirmed by a recent case report of two patients falling after an MRI examination (24).

According to these premises, the aim of this study is to report, for the first time in Italy, the results of a multi-center investigation of reported non-specific subjective symptoms in a group of MRI personnel, evaluating the presence of the suggested "core symptoms" and their distribution according to the characteristics of the exposed subjects and possible confounding factors.

MATERIALS AND METHODS

Study Setting and Population

Between June 2013 and September 2016, we performed a multi-center observational study involving personnel employed in the radiology units of six different centers in Italy: the hospitals of the cities of Modena, in northern Italy, Florence and Siena in central Italy, Bari and Rome in the south, and, also in Rome, a radiology research center of the National Research Council (CNR).

Based on some preliminary results and on the scientific literature on the subjective symptoms reported by MRI personnel (9–14), we developed an original Italian questionnaire that was previously applied during two single-center pilot studies involving a sub-sample of 17 young resident physicians attending a post-graduate medical school in radiology and engaged in MRI for <1 year (1, 15). For more details on the questionnaire, we have enclosed as **Supplementary Material** a full translated version of the tool used. Briefly, the questionnaire surveys 36 items, including sociodemographic and occupational characteristics, with details on the type of MRI scanners and the amount of time employed as MRI personnel, and information on the personnel's health status, related to both previous relevant diseases and drug intake, and investigating in particular 11 specific symptoms: vertigo, nausea, tinnitus, metallic taste, magnetophosphenes, headache, drowsiness, concentration problems, balance instability, memory loss, and sleep disorders. The frequency of the symptoms was estimated based on a Likert scale (never or less than once a month, at least once a month, one-four times per week, more than four times per week). The MRI personnel were also asked to indicate whether they felt that the origin of the reported symptoms was related to the MRI exposure, whether the symptoms were present during the MRI work shift, and when the symptoms appeared and disappeared in relation to the MRI shifts.

As work-related stress can be a relevant confounder for the appearance of several of the subjective symptoms investigated, a specific item of the questionnaire (item 17) was used to evaluate job stress, following the verification of internal consistency with other items investigating specific factors related to job content and context that may pose a risk of work-related stress (items 5–9). The question used provides a definition of work-related stress and asks the participants to judge whether they had experienced that kind of stress during the last 12 months on a five-point Likert-like scale (not at all, slightly, moderately, definitely, extremely). For the analysis presented in this manuscript, the five-point score was grouped into three categories: (1). Absence of job stress, corresponding to the "not at all" answer to item 17; (2). medium job stress experienced in the last year, corresponding to the answers "slightly" and "moderately"; and (3). high job stress, attributed to the answers "definitely" and "extremely." Another important question, used mainly to verify whether there was a difference in self-perception of health conditions comparing exposed and unexposed subjects, was item 16. This question asks the participants to judge their level of agreement or disagreement on a five-point Likert scale with the statement "Your health conditions are good." For the analysis presented in this report, we grouped together subjects who indicated agreement/extreme agreement in the category of "good health status," comparing it with subjects who indicated another judgement.

All the questionnaires were collected anonymously and on a voluntarily basis, and the study was approved by the Institutional Review Board (reference number 2443/CE).

The inclusion criteria for the study were:

- Being an employee of a radiology unit of one of the six research and medical centers included in the multi-center study;
- Being between 18 and 70 years old;
- Voluntarily accepting to participate in the research, signing the informed consent.

We excluded subjects taking pharmaceutical drugs or in any case with diseases, diagnosed by a physician, that would interfere with the subjective symptoms evaluated.

Exposure Evaluation

We considered MRI personnel as all health care workers (HCWs) who stated that they had worked shifts involving work with MRI scanners during the previous year. Other HCWs were considered as unexposed controls.

Unfortunately, no objective measurements for determining the levels of electromagnetic field exposure were available, so the exposure of the MRI personnel was estimated based on the questionnaire answers related to the type of scanner and the reported number of procedures, i.e., the number of patient examinations with the operator working inside what is known as the "controlled access area" (CAA) according to the European Directive 2013/35/EU, where SMF intensity >0.5 mT is expected (25, 26). It should be noted that working in the CAA does not necessarily mean that the operator enters the scanner room during the examination or is actually exposed to MRI-related EMFs. In the exposed group, we evaluated the strength of the MRI scanner used (i.e., <1.5, 1.5, or ≥3 T), the estimate of the average number of hours spent with direct involvement in MRI procedures during a work shift and the total number of MRI procedures per year reported, as well as the number of years spent working with MRI. We then considered eventual modifications of the reported symptoms' duration and occurrence in relation to the type of scanner used. For this purpose, we also performed a simple analysis grouping the MRI personnel into two categories: $\leq$ 1.5 vs. $\geq$ 3 T, adopting the criterion according to which a higher field strength could indicate higher SMF exposure, even if it is possible that some subjects included in the $\geq$ 3 T group have also reported procedures with the $\leq$ 1.5 T scanners. The full questionnaire and the database in the **Supplementary Materials** provide more details on how the information on the potential exposure of MRI personnel was collected.

Statistical Analysis

Student's *t*-test (or non-parametric Wilcoxon-Mann-Whitney test) was used to compare the mean/median values between two groups of subjects (e.g., exposed vs. unexposed, men vs. women, exposed to MRI scanners with strengths of $\leq$ 1.5 vs. $\geq$ 3 T, etc.).

Chi-Square test (or Fisher's exact test) was used to evaluate the association between categorical variables. Pearson's (or Spearman's) correlation coefficient was used to analyze correlations between variables. Then, to evaluate the impact of the variables considered on the symptoms, multivariate regression models were built.

All the analyses were conducted using the statistical software package SAS version 9.4 for Windows. Statistical significance for all tests was set at a $p \leq 0.05$.

RESULTS

The following subsections present the results of the study, including the characteristics of the study population divided into an MRI-exposed group and an unexposed group, according to age, BMI, gender, job title, health status, and job stress level (**Table 1**). In addition, the occurrence of the investigated subjective symptoms is shown in **Table 2**. Finally, the same symptoms were analyzed in relation to the reported annual number of MRI procedures by the personnel, also considering the strengths of the scanners, and the role of job stress.

Study Population

The total number of responders included 283 subjects working in six different radiology units of hospitals and research centers in Italy. According to the exclusion criteria, 43 HCWs were excluded, resulting in a final sample of 240 subjects, between 26 and 65 years of age (mean = 42.2 ± 10.1 SD), with a slightly higher percentage of women (55.4%).

The main occupations of the subjects were as follows:

- Medical doctors (radiologists, surgeons, anesthesiologists, ophthalmologists, cardiologists, and resident physicians of the same specializations): $n = 101$ (42.1% of the sample);
- Research staff: 24 subjects (10.0% of the sample);

TABLE 1 | Overview of the study population ($n = 240$ subjects).

Characteristics	Exposed ($n = 177$; 74%)	Unexposed ($n = 63$; 26%)
	Mean ± SD	
Age in years	42.4 ± 9.9	42.5 ± 1 0.6
BMI	24.1 ± 3.7	24.1 ± 4.6
Gender	*n (%)*	
• Male	84 (47.5)	23 (36.5)
• Female	93 (52.5)	40 (63.5)
Job title		
• Medical doctor	80 (45.2)	21 (33.3)
• Other health and technical personnel	80 (45.2)	35 (55.6)
• Research staff	17 (9.6)	7 (11.1)
Perceived job stress*		
• Absent	54 (30.5)	24 (38.1)
• Medium	108 (61.0)	34 (54.0)
• High	14 (7.9)	5 (7.9)
Health status*		
• Good	144 (81.8)	49 (78.4)
• Not good	32 (18.2)	14 (21.6)

Differences between the MRI exposed group and unexposed group are not statistically significant.
**Values missing for 1 exposed subject.*

TABLE 2 | Frequency of reported symptoms occurring at least once a week given as *n* subjects (%).

Symptom	Study population $n = 240$ (100%)	Exposed $n = 177$ (74%)	Unexposed $n = 63$ (26%)
Vertigo	11 (4.6)	9 (5.1)	2 (3.2)
Nausea	3 (1.3)	2 (1.1)	1 (1.6)
Concentration problems	20 (8.3)	15 (8.5)	5 (7.9)
Memory loss	11 (4.6)	6 (3.4)	5 (7.9)
Drowsiness	55 (22.9)	43 (24.3)	12 (19.1)
Headache	49 (20.4)	36 (20.3)	13 (20.6)
Metallic taste	2 (0.8)	2 (1.1)	0 (0.0)
Balance instability	13 (5.4)	10 (5.7)	3 (4.8)
Magnetophosphenes	1 (0.4)	0 (0.0)	1 (1.6)
Tinnitus	8 (3.3)	6 (3.4)	2 (3.2)
Sleep disorders	39 (16.3)	25 (14.1)	14 (22.2)

None of the evaluated symptoms differed between exposed and unexposed subjects ($p > 0.05$).

- Other healthcare and MRI-related technical staff (mainly nurses and radiology technicians): $n = 115$ (47.9% of the sample).

Of the 240 subjects, 177 reported having worked with an MRI scanner in the previous 12 months. Accordingly, the exposed group represents 74% of the sample, and it includes 80 medical doctors (45.2%), 80 nurses and technicians (45.2%) and 17 researchers (9.6%). In the exposed group, 114 subjects (64.4%) worked with MRI scanners of intensity $\leq$ 1.5 T, with a mean number of procedures in the previous year of 682, while 63 subjects (35.6%) used also, or exclusively, scanners $\geq$ 3 T with an average number of procedures equal to 238. Only 10 subjects reported the use of both 3 T and $\geq$ 3 T scanners.

No significant differences were detected for any occupational variable or for any sociodemographic characteristic between the exposed group and the unexposed group, including gender ($p = 0.13$). We found no significant differences in job stress perception between exposed and unexposed subjects. A high level of work-related stress was perceived in a relatively small percentage of subjects: 7.9% of both the exposed and unexposed subjects ($p = 0.547$). The health status of the subjects was subjectively evaluated as "good" by 81.8% of subjects in the exposed group and by 78.4% of subjects in the unexposed group ($p = 0.788$) (**Table 1**).

Evaluation of Symptoms: Characteristics and Frequency

Overall, the majority of the subjects (86.4%) complained of no less than one symptom during the last year with a frequency of at least once a month, and 42.3% of the subjects complained of symptoms with a frequency of at least once a week. No significant differences were observed between the occurrence of the symptoms in the MRI exposed group compared to the unexposed subjects.

The occurrence of subjective symptoms in the previous 12 months (with a frequency of at least once a week) is reported in **Table 2**.

Limiting the analysis to the five core symptoms (i.e., vertigo, nausea, head ringing, magnetophosphenes, and metallic taste), once again no significant differences in the occurrence of the symptoms were found between exposed and unexposed subjects.

Regarding the symptoms reported, in the whole population the mean number was 3.1 (±2.5 SD), with a maximum of 10 symptoms in only one subject; limiting the analysis to more frequent symptoms (at least "once a week" frequency), the mean number of reported symptoms was 0.88 (±1.4 SD).

In the whole group, no significant difference was observed between exposed and unexposed personnel considering symptoms with any frequency or with at least weekly occurrence.

Finally, regarding job characteristics, we examined the occurrence of weekly symptoms in three different occupational categories (i.e., medical doctors, nurses, and technical staff and researchers). In the whole sample, the most frequent symptoms were drowsiness, headache, and sleep disorders, reported by 22.9, 20.4, and 16.2% of subjects, respectively. No significant differences were observed for the occurrence of these symptoms in any of the three occupational groups. Even when considering only "core symptoms," no significant differences in their occurrence were found among the three occupational groups (see **Supplementary Table 1**).

Associations Between Reported Symptoms in the Exposed Group, Type of MRI Scanner Used, and Reported Number of MRI Procedures

In the exposed group, a significant increase in the mean number of symptoms was observed when comparing personnel working

with scanners up to 1.5 T (mean number of symptoms = 2.8 ± 2.4 SD) with those working also, or exclusively, with scanners with a field strength ≥ 3 T (mean = 3.7 ± 2.6 SD; $p = 0.0238$). However, this difference disappeared when considering only symptoms with a frequency of at least once a week (mean number in the ≥ 3 T sub-group = 0.8 ± 1.3 SD vs. 0.9 ± 1.4 SD in the ≤ 1.5 T sub-group).

Considering the total number of annual MRI procedures reported by the personnel, no significant associations were found with the total number of symptoms, nor with "core symptoms."

As regards the specific symptoms, only subjects with drowsiness reported a mean annual number of MRI procedures with ≤ 1.5 T scanners higher when compared with exposed subjects without drowsiness (752.7 ± 802.8 SD vs. 481.0 ± 6 54.2, $p = 0.02$).

Associations Between Subjective Symptoms in MRI Personnel, Number of MRI Procedures Reported, and Perceived Occupational Stress in a Multivariate Model

As a potential confounder, we evaluated the possible influence of job stress in relation to the occurrence of symptoms in the investigated sample. Subjects with a high level of perceived job stress complained of an average of 0.6 (±0.9 SD) core symptoms occurring at least once a week. This value was found to be lower in subjects with a medium job stress perception level (0.0 ± 0.2 SD) and in subjects without work-related stress (0.1 ± 0.5 SD). A positive association between stress levels and the average numbers of reported core symptoms per person was found ($p = 0.0002$). We then performed a multivariate regression analysis investigating the association between core symptoms, the reported number of annual MRI procedures attended and/or performed by the personnel, and scanner field strength. The model is adjusted for sex and age and includes job stress as a confounding factor. A significant association was found between stress and the reporting of core symptoms with a frequency of at least once a week, indicating a negative effect of low stress levels on symptom occurrence (OR = 0.19; CI 95%: 0.04–0.93).

DISCUSSION

Our study did not find significant higher reporting of subjective symptoms in the whole group of MRI personnel potentially exposed to static and low-frequency time-varying magnetic fields during MRI-related activities. We did not find an increased prevalence of symptoms when comparing exposed and unexposed subjects, or when comparing, within the sub-group of the exposed individuals, the personnel working with scanners of a field strength ≤1.5 T with those also working with ≥3 T MRI scanners, or according to the annual number of MRI procedures reported. Also considering the sub-group of "core symptoms" (12), we did not find an increased prevalence of these symptoms in the exposed subjects. This finding is partially in contrast with the results obtained by Schaap et al. suggesting an exposure-response association between exposure to SMFs and the reporting of transient symptoms, especially on the same day of the exposure and mainly considering core symptoms, and in particular vertigo (12, 13). The lack of association we found may be explained by the subjective investigation of the exposure performed, not considering, differently from these other studies, objective measurements of EMF exposure, and, moreover, not collecting information on how frequently the MRI personnel entered the scanner room, how close to the bore they were, and what kind of movements they performed. The subjective information on the exposure we collected are similar to those obtained in the study by Wilén et al. but in that case the sample was more homogeneous, including only nurses, and the authors found that the symptoms reported by the MRI personnel were related to the field strength of the magnet the nurses worked with (14).

In line with earlier research and considering these limitations of our study it should still be considered useful to evaluate the occurrence of these health complaints during health surveillance of MRI personnel (8). The importance of investigating these symptoms is not only related to their possible association with EMF exposure during MRI activities, as previously reported (12–14), but it should be considered that a systematic collection of these symptoms may help the occupational physicians responsible for the health surveillance of MRI personnel in identifying groups of subjects at "particular risk," as indicated in European Directive 2013/35 (8). In fact, many of these symptoms, and in particular core symptoms, can be considered sensory effects of exposure to magnetic fields, and they are particularly related to the performance of physical movements within a static magnetic field. The probability of occurrence of the effects depends on the strength of the magnetic field and on the acceleration, velocity, and direction of the movement with respect to the magnetic field gradient (4–6). Furthermore, it cannot be excluded that subjects with diseases causing the same sensory effects (e.g., the Meniere's disease for vertigo) may be more susceptible to EMF effects, being therefore at a "particular risk," even in the case of low exposure levels (8).

Another aspect to be mentioned here is the role played by perceived work stress on the investigated symptoms. The influence of work-related stress on subjective symptoms is not unexpected (1, 15), but was scarcely considered in similar studies previously conducted on MRI personnel. We found that the subjects with higher perceived stress levels reported a higher mean number of symptoms. Moreover, in the adjusted model we developed it was found that job stress levels were significantly associated with the average number of core symptoms reported by the subjects.

Our study has some limitations, some of them intrinsically related to the issue investigated. The subjective symptoms collected in this study, even though selected according to the potential relation with the action of the strong magnetic fields related to the MRI scanner during occupational activities as MRI personnel, resulted as extremely frequent in the whole group, i.e., more than 80% of the participants, regardless of exposure to MRI-related EMF fields, reported at least one of the symptoms at least once a month. The most frequent

single-specific symptoms in the whole group were drowsiness, headache, and sleep disorders, involving 15–25% of the overall sample. In order to partially overcome this limitation, all the analyses in this study were done defining the group of personnel with symptomatic manifestations, based on an occurrence of the symptoms at least once a week. Moreover, it should be considered that these symptoms are also frequent in the general population, and they have various potentially relevant occupational and non-occupational factors that can play a role in their induction (27–29). For these reasons, it is important for the interpretation of the results that the composition of the studied sample was sufficiently homogeneous, as we found no significant differences in age, sex ratio, distribution according to the job categories considered, levels of perceived job stress, and perceived health status between exposed subjects, i.e., those directly involved in MRI activities within the controlled access area, and the unexposed group, working in the same department (though it should be noted that the number of unexposed workers was significantly lower compared with the number of MRI personnel). These data are relevant, as for some of the symptoms evaluated we could expect higher reporting in sub-groups of subjects such as women (e.g., for nausea, vertigo, and headache) (29, 30) or older subjects (e.g., for tinnitus, instability, sleep disorders) (31, 32). Furthermore, we excluded the subjects who reported a diagnosis of diseases and a long-term assumption of drugs that could possible interfere with the occurrence of the investigated symptoms (1, 15).

Another limitation of our research is related to the observational design of the study, according to which exposure cannot be controlled by the investigators, and issues such as the presence of bias and confounding factors are more common compared to experimental interventional studies. Moreover, in the case of this study the observation was retrospective, so that we cannot exclude a problem of recall bias in reporting the symptoms, also because the majority of the results were reported in univariate analysis showing the association between symptom occurrence and the type of MRI scanners and the number of procedures. Nevertheless, to partially overcome this limitation, we also built a multivariate regression analysis including adjustments for sex, age, and job stress levels.

Finally, a further important weakness to overcome in future studies in this field is the lack of an objective exposure evaluation. Individual exposure measurements in MRI personnel are intrinsically difficult due to several types of technical and organizational factors, but on the other hand the subjective evaluation based on job categories and on questionnaire data can give only a rough picture of the actual individual levels and can possibly be a cause of the lack of significance of the results. Furthermore, with our questionnaire mainly designed to help occupational physicians in collecting relevant clinical data useful for the health surveillance of the MRI personnel, we did not capture important information on the exposure of the subjects, e.g., how frequently they entered in the scanner rooms, the amount of time spent inside, the distance from the bore, and the actions performed, including the velocity of the movements. Moreover, the different job categories of MRI personnel considered represent a significant source of heterogeneity, as specific occupations may have specific exposures to the magnetic fields during different MRI procedures according to their roles and work tasks. Furthermore, considering the reporting of the MRI procedures by the personnel, in our analysis we did not distinguish between workers operating only with $\leq$1.5 or $\geq$3 T scanners, or with both, and we did not differentiate the personnel performing the procedures and those only attending. In future studies an improvement of all these abovementioned aspects is of paramount importance.

CONCLUSIONS

Our study did not show any association between the occurrence of reversible subjective symptoms, including the more specific "core symptoms," and the occupational exposure of MRI personnel to static and low-frequency time-varying magnetic fields. On the other hand, the role played by occupational stress appears to not be negligible. In further research in this field, measurements of EMF exposure or equivalents should be considered. To be able to perform relevant health surveillance of MRI personnel by occupational physicians it will be necessary to validate tailored questionnaires not least to identify personnel at particular risk.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comitato Etico dell'Area Vasta Emilia Nord. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FG and AM: conceptualization and writing—review and editing. FG, GB, and AM: methodology. GB and FG: software. GB, AM, and IV: formal analysis. GA, NM, GZ, SG, RM, VC, SZ, GC, GL, and LV: investigation. FG, GA, NM, SG, RM, VC, SZ, GC, GL, and LV: resources. GZ, IV, GB, and AM: data curation. GB, CB, MM, and IV: writing—original draft preparation. GA, FG, LV, SZ, RM, and GL: supervision. FG: project administration. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.699675/full#supplementary-material

REFERENCES

1. Zanotti G, Ligabue G. Gobba F. Subjective symptoms and their evolution in a small group of Magnetic Resonance Imaging (MRI) operators recently engaged. *Electromagn Biol Med.* (2015) 34:262–4. doi: 10.3109/15368378.2015.1076442
2. Ladd ME, Bachert P, Meyerspeer M, Moser E, Nagel AM, Norris DG, et al. Pros and cons of ultra-high-field MRI/MRS for human application. *Prog Nucl Magn Reson Spectrosc.* (2018) 109:1–50. doi: 10.1016/j.pnmrs.2018.06.001
3. Menon RG, Chang G, Regatte RR. Musculoskeletal MR imaging applications at ultra-high (7T) field strength. *Magn Reson Imaging Clin N Am.* (2021) 29:117–27. doi: 10.1016/j.mric.2020.09.008
4. Vecchia P, Hietanen M, Ahlbom A, Anderson LE, Breitbart E, de Gruijl FR, et al. Guidelines on limiting exposure to static magnetic fields. *Health Phys.* (2009) 96:504–14. doi: 10.1097/01.HP.0000343164.27920.4a
5. Vecchia P, Hietanen M, Matthes R, Ahlbom A, Breitbart E, de Gruijl F R, et al. Guidelines for limiting exposure to time-varying electric and magnetic fields (1HZ - 100 kHZ). *Health Phys.* (2010) 99:818–36. doi: 10.1097/HP.0b013e3181f06c86
6. Matthes R, Feychting M, Croft R, Green A, Jokela K, Lin JC, et al. Guidelines for limiting exposure to electric fields induced by movement of the human body in a static magnetic field and by time-varying magnetic fields below 1 HZ. *Health Phys.* (2014) 106:418–25. doi: 10.1097/HP.0b013e31829e5580
7. Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Phys.* (2020) 118:483–524. doi: 10.1097/HP.0000000000001210
8. Modenese A, Gobba F. Occupational exposure to electromagnetic fields and health surveillance according to the European directive 2013/35/EU. *Int J Environ Res Public Health*. (2021)18:1730. doi: 10.3390/ijerph18041730
9. Chakeres DW, de Vocht F. Static magnetic field effects on human subjects related to Magnetic Resonance Imaging systems. *Prog Biophys Mol Biol.* (2005) 87:255–65. doi: 10.1016/j.pbiomolbio.2004.08.012
10. de Vocht F, Stevens T. van Wendel-de-Joode B, Engels H, Kromhout H. Acute neurobehavioral effects of exposure to static magnetic fields: analyses of exposure-response relations. *J MagnReson Imaging.* (2006) 23:291–7. doi: 10.1002/jmri.20510
11. de Vocht F, Batistatou E, Mölter A, Kromhout H, Schaap K, van Tongeren M, et al. Keevil S. Transient health symptoms of MRI staff working with 15 and 30 Tesla scanners in the UK. *Eur Radiol.* (2015) 25:2718–26. doi: 10.1007/s00330-015-3629-z
12. Schaap K. Christopher-de Vries, Y, Mason CK, de Vocht F, Portengen L, Kromhout H Occupational exposure of healthcare and research staff to static magnetic stray fields from 15-7 Tesla MRI scanners is associated with reporting of transient symptoms. *Occup Environ Med.* (2014) 71:423–9. doi: 10.1136/oemed-2013-101890
13. Schaap K, Portengen L, Kromhout H. Exposure to MRI-related magnetic fields and vertigo in MRI workers. *Occup Environ Med.* (2016) 73:161–6. doi: 10.1136/oemed-2015-103019
14. Wilén J, de Vocht F. Health complaints among nurses working near MRI scanners – a descriptive pilot study. *Eur J Radiol.* (2011) 80:510–3. doi: 10.1016/j.ejrad.2010.09.021
15. Zanotti G, Ligabue G, Korpinen L, Gobba F. Subjective symptoms in Magnetic Resonance Imaging operators: prevalence, short-term evolution and possible related factors. *Med Lav.* (2016) 107:263–70. Available online at: https://www.mattioli1885journals.com/index.php/lamedicinadellavoro/article/view/5240
16. Bongers S, Slottje P, Portengen L, Kromhout H. Exposure to static magnetic fields and risk of accidents among a cohort of workers from a medical imaging device manufacturing facility. *Magn Reson.* (2016) 75:2165–74. doi: 10.1002/mrm.25768
17. Huss A, Schaap K, Kromhout H. MRI-related magnetic field exposures and risk of commuting accidents – a cross-sectional survey among Dutch imaging technicians. *Environ Res.* (2017) 156:613–8. doi: 10.1016/j.envres.2017.04.022
18. de Vocht F. van-Wendel-de-Joode B, Engels H, Kromhout H. Neurobehavioral effects among subjects exposed to high static and gradient magnetic fields from a 15 Tesla Magnetic Resonance Imaging system – a case-crossover pilot study. *Magn Reson Med.* (2003) 50:670–4. doi: 10.1002/mrm.10604
19. de Vocht F, Stevens T, Glover P, Sunderland A, Gowland P, Kromhout H. Cognitive effects of head-movements in stray fields generated by a 7 Tesla whole-body MRI magnet. *Bioelectromagnetics.* (2007) 28:247–55. doi: 10.1002/bem.20311
20. Heinrich A, Szostek A, Meyer P, Nees F, Rauschenberg J, Gröbner J, et al. Cognition and sensation in very high static magnetic fields: a randomized case-crossover study with different field strengths. *Radiology.* (2013) 266:236–45. doi: 10.1148/radiol.12112172
21. van Nierop LE, Slottje P, van Zandvoort MJE, de Vocht F, Kromhout H. Effects of magnetic stray fields from a 7 Tesla MRI scanner on neurocognition: a double-blind randomised crossover study. *Occup Environ Med.* (2012) 69:759–66. doi: 10.1136/oemed-2011-100468
22. van Nierop LE, Slottje P, Kingma H, Kromhout H. MRI-related static magnetic stray fields and postural body sway: a double-blind randomized crossover study. *Magn Reson Med.* (2013) 70:232–40. doi: 10.1002/mrm.24454
23. van Nierop LE, Slottje P, van Zandvoort M, Kromhout H. Simultaneous exposure to MRI-related static and low-frequency movement-induced time-varying magnetic fields affects neurocognitive performance: a double-blind randomized crossover study. *Magn Reson Med.* (2015) 74:840–9. doi: 10.1002/mrm.25443
24. Botwe BO, Antwi WK, Ofori-Manteaw BB. Falling post-MRI examinations: 2 case reports. *Heliyon.* (2020) 6:e03949. doi: 10.1016/j.heliyon.2020.e03949
25. *Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the Minimum Health and Safety Requirements Regarding the Exposure of Workers to the Risks Arising from Physical Agents (Electromagnetic Fields) (20th Individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and Repealing Directive 2004/40/EC.* Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013L0035 (accessed July 8, 2021)
26. *Directorate-General for Employment, Social Affairs and Inclusion (European Commission). Non-binding guide to good practice for implementing Directive 2013/35/EU Electromagnetic Fields. Volume 1, Practical guide. European Union*. Available online at: https://op.europa.eu/en/publication-detail/-/publication/c6440d35-8775-11e5-b8b7-01aa75ed71a1 (accessed July 8, 2021)
27. Kjeldsberg M, Tschudi-Madsen H, Dalen I, Straand J, Bruusgaard D, Natvig B. Symptom reporting in a general population in Norway: results from the Ullensaker study. *Scand J Prim Health Care.* (2013) 31:36–42. doi: 10.3109/02813432.2012.751697
28. Hutter HP, Kundi M, Lemmerer K, Poteser M, Weitensfelder L, Wallner P, et al. Subjective symptoms of male workers linked to occupational pesticide exposure on coffee plantations in the Jarabacoa Region, Dominican Republic. *Int J Environ Res Public Health.* (2018) 15:2099. doi: 10.3390/ijerph15102099
29. Tiseo C, Vacca A, Felbush A, Filimonova T, Gai A, Glazyrina T, et al. European headache federation school of advanced studies (EHF-SAS). Migraine and sleep disorders: a systematic review. *J Headache Pain.* (2020) 21:126. doi: 10.1186/s10194-020-01192-5
30. Chen J, Zhao W, Yue X, Zhang P. Risk factors for the occurrence of benign paroxysmal positional vertigo: a systematic review and meta-analysis. *Front Neurol.* (2020) 11:506. doi: 10.3389/fneur.2020.00506
31. Theodoroff SM, Lewis MS, Folmer RL, Henry JA, Carlson KF. Hearing impairment and tinnitus: prevalence, risk factors, and outcomes in US service members and veterans deployed to the Iraq and Afghanistan wars. *Epidemiol Rev.* (2015) 37:71–85. doi: 10.1093/epirev/mxu005
32. Orr R. Contribution of muscle weakness to postural instability in the elderly. a systematic review. *Eur J Phys Rehabil Med.* (2010) 46:183–220. Available online at: https://www.minervamedica.it/it/riviste/europa-medicophysica/articolo.php?cod=R33Y2010N02A0183

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Interplay Between Adherence to the Mediterranean Diet and Lipid Profile: A Comparative Survey Between Day-Time Healthcare and Non-healthcare Female Workers

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Introduction: Occupational physicians, as an aspect of the periodic health surveillance of workers prescribed by law, must develop preventive programs against adverse health-related occurrences (Legislative Decree 81/2008, art.25) to reduce major risk factors for non-communicable/chronic diseases. Eating habits play an important role in defining risk trajectories in the workplace.

Methods: We randomly and cross-sectionally evaluated 147 females, of which 59 were healthcare workers (HCWs) and 88 were non-HCWs. The assessment included a dietary screening for adherence to the Mediterranean diet (MD) and a clinical baseline collection of major fluid biomarkers and anthropometric indicators for cardiovascular and metabolic risk.

Results: The HCW group exhibited greater adherence to the MD than the non-HCW group. Nevertheless, they showed higher serum levels of triglycerides and total cholesterol. Menopause and type of work significantly and unfavorably affected triglyceride serum levels among HCWs.

Conclusion: Greater preventive efforts are needed in the context of periodic health surveillance by occupational physicians. Disseminating additional information on a healthier lifestyle, particularly among female workers of perimenopausal age, is a key issue.

Keywords: Mediterranean diet, blood lipid profile, healthcare workers, health promotion, occupational medicine

INTRODUCTION

The Mediterranean diet (MD) is a diet common to the inhabitants of lands surrounding the Mediterranean Sea, originally observed in Southern Italy in the 1960s and specifically described based on food consumption patterns in the Greek Peninsula (1, 2). This dietary pattern features higher consumption of vegetables and lower intake of animal foods and is widely recognized as a key driver of the lower rate of mortality from cardiovascular disease (CVD), as observed in the Corfu and Crete cohorts at 25 years of follow-up (1). In particular, MD defines a nutritional model characterized by high consumption of seasonal vegetables, fresh fruits and nuts, legumes and cereals, which ensure an appropriate intake of fiber and starch; moreover, a specific peculiarity of MD is the use of extra virgin olive oil (EVOO), rich in monounsaturated fatty acids, as the main lipid source, and low intake of saturated fatty acids. A moderate consumption of fish, dairy products, eggs and red wine (for its antioxidant activity) is allowed (1–4). Several studies have demonstrated the association between adherence to MD and reduced prevalence of cardiovascular risk factors such as abdominal fat (5, 6), hypertension (7), dyslipidemia (8), diabetes mellitus (9), CVD (10, 11) and cancer (12). Interestingly, we found that low adherence to MD was also associated with lower circulating levels of 25-OH-vitamin D (6). All these benefits are largely derived from daily consumption of 25–50 ml/day EVOO, which seems most importantly to work well in decreasing LDL atherogenicity and thus CV risk. This is notable since LDL cholesterol is accepted as a causal risk factor for the development of myocardial infarction and atherosclerotic CVD (13).

Although extensive research has consistently provided proof of the numerous beneficial effects of the MD, especially in the context of prevention of CV and metabolic diseases, a shift of the traditional MD pattern toward the so-called "Western diet" (characterized by a greater consumption of refined grains, sugars and red and processed meats) has paradoxically been occurring over the last few decades, even in Mediterranean countries (14).

These changes in Italian eating habits have resulted from a combination of widespread urbanization, globalization and economic crises, at least since the end of the last century, and are often associated with an increase in sedentary work and lifestyle patterns (15).

Thus, from a preventive perspective, the MD should be promoted to a greater extent in Mediterranean countries, especially among individuals of working age. In this regard, the role of occupational physicians is of particular significance, as these professionals are responsible for the management and prevention of diseases related to workplace factors, especially to ensure regular health surveillance of workers exposed to occupational health and safety risks (16). In addition, in high-income countries, health promotion is useful for balancing the reduction of work-related metabolic and CV risk factors with the increase in subjective risk factors due to new and often unhealthy lifestyles (17). The practice of using lifestyle corrective programs during periodic worker health surveillance by occupational physicians may be exceptionally useful in reducing the risk of chronic diseases, particularly in southern Italy, where, at the expense of a higher incidence of obesity, there is a lower prevalence of obesity treatment centers (18, 19).

Indeed, several Italian studies have shown that the promotion of MD in the workplace helps to increase the consumption of whole grains, legumes, white meat and fish and to moderate that of foods rich in cholesterol, saturated fats and sugars (20). In a sample of Italian healthcare workers (HCWs), it was found that the adoption of unhealthy lifestyles, together with shift work, is an additional risk factor for CV and metabolic diseases (21). Accordingly, a recent record from US HCWs showed that greater adherence to MD can reduce CV risk factors and the incidence of coronary heart disease (CHD) (22). This result is of particular interest because HCWs show higher CV risk due to the higher number of work-related stressors (23). Finally, it should be noted that CV and metabolic risk increase significantly with menopause, and this physiological condition may accompany 15–20 years of female working age (24).

The objective of this study was to assess possible differences in adherence to the MD and major metabolic and anthropometric parameters between adult female HCWs (healthcare workers) and non-HCWs (non-Healthcare Workers), to determine any association that could help occupational physicians improve preventive health risk management.

MATERIALS AND METHODS

Study Population and Design

A transversal observational study was conducted. One hundred forty-seven subjects were randomly recruited at the Operating Unit of Occupational Medicine of the University Polyclinic Hospital of Bari (Apulia, Southern Italy) in the last quarter of 2019. The whole sample included only female employees of public companies with at least 16 years of education and subject to health surveillance by the occupational physicians of the above operating unit, subdivided as follows: 59 HCWs (doctors and professional nurses employed at the University Hospital of Bari) and 88 employees of other public companies not operating in the field of healthcare (non-HCWs). All the workers were Italian and lived in Puglia. Given that the working schedule of companies employing non-HCWs did not include both day and night shifts, only non-shift HCWs were recruited to avoid the influence of shift work on eating habits and metabolic status (25). Biological sex differentially determines susceptibility to cardiovascular and metabolic risks, so we preferred to analyze only female workers in this study (26).

The study protocol (ClinicalTrials.gov Identifier: NCT04596358) met the principles of the Declaration of Helsinki and was approved by the Ethics Committee of the National Cancer Research Center "Giovanni Paolo II," Bari, Italy. All participants gave informed consent prior to enrollment, in accordance with the Helsinki Declaration of 1964 and subsequent revisions.

Clinical Examination and Fluid Biomarker Collection

As part of the periodic health surveillance, a senior physician conducted a cross-sectional evaluation consisting of a brief interview on medical history and lifestyle. Extemporaneous outpatient diastolic blood pressure (DBP) and systolic blood pressure (SBP) were determined in a sitting position after at least a 10-min rest, a minimum of three different times, using an OMRON M6 automatic blood pressure monitor. Subjects with BP values > 130/85 mm Hg or already under drug therapy were classified as currently suffering from hypertension (27).

Metabolic and routine biochemical parameters were closely examined in all subjects. Blood samples were drawn between 08:00 and 09:00 a.m. after overnight fasting. Fasting plasma glucose (FPG), total cholesterol, high- and low-density lipoprotein (HDL, LDL) cholesterol, and triglyceride (TG) serum levels were assayed. Plasma glucose was determined using the glucose oxidase method (Sclavus, Siena, Italy), while the concentrations of plasma lipids (triglycerides, total cholesterol, HDL cholesterol) were quantified by the automated colorimetric method (Hitachi; Boehringer Mannheim, Mannheim, Germany). LDL cholesterol was directly determined in blood samples. Subjects with circulating LDL cholesterol > 116 mg/dl or already under drug therapy were classified as having hypercholesterolemia (28).

Anthropometric Assessment

Clinical procedures were performed by two qualified nutritionists (RZ and LL) trained for equivalent measuring performances. All anthropometric measurements were taken with participants dressed in lightweight clothing and without shoes. Variables were all collected at the same time between 7:00 and 10:00 a.m. after overnight fasting. Height was measured to the nearest 0.5 cm using a wall-mounted stadiometer (Seca 711; Seca, Hamburg, Germany). Body weight was determined to the nearest 0.1 kg using a calibrated balance beam scale (Seca 711; Seca, Hamburg, Germany). BMI was calculated by dividing body weight (kg) by the square of height (m^2) and classified according to World Health Organization criteria for normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), grade I obesity (30.0–34.9 kg/m^2), grade II obesity (35.0–39.9 kg/m^2), and grade III obesity ($\geq$40.0 kg/m^2) (29). Waist circumference (WC) was measured at the narrowest part of the abdomen or in the area between the 10th rib and the iliac crest (minimum circumference). Subjects with previous diagnoses of hypertension, diabetes mellitus, hypercholesterolemia, hypertriglyceridemia and related drug therapies were identified. In addition, subjects with physiological amenorrhea for at least 12 months, as well as those with iatrogenic amenorrhea, were recorded as menopausal (30).

Assessment of Adherence to a MD

Two senior nutritionists (RZ and LL) administered a previously validated 11-item index, the MedDietScore (MD score) (31), to assess adherence to a MD. The MD score developed by Panagiotakos and colleagues was chosen because of its corroborated applicability and psychometric quality (32). Female workers were interviewed individually at the time of medical examination by the above nutritionists.

For food items presumed to be close to the MD pattern (i.e., those that are suggested to be consumed on a daily basis or in >4 servings/week: unrefined cereals, fruits, vegetables, potatoes, legumes, olive oil and fish), a score of 0 was assigned when a participant reported no consumption, a score of 1 was assigned for reported consumption of 1–4 times/month, a score of 2 for 5–8 times/month, a score of 3 for 9–12 times/month, a score of 4 for 13–18 times/month and a score of 5 for >18 times/month. In contrast, for the consumption of foods presumed to be inconsistent with this dietary pattern (i.e., those suggested not to be consumed on a daily or weekly basis: meat and meat products, poultry and high-fat dairy products), the opposite scores were assigned (i.e., a score of 0 when a participant reported almost daily consumption of the food to a score of 5 for rare or no consumption). For alcohol consumption, a non-monotonic scoring was adopted based on daily intake of 15–30 g ethanol as suggested by the MD pattern (i.e., a score of 5 was assigned for consumption of <3 glasses/d; 0 for none or consumption of >7 glasses/d; and scores of 4, 3, 2 and 1 for the consumption of 3, 4–5, 6 and 7 glasses/d, respectively). The resulting total score ranged from 0 to 55.

Statistical Analysis

Data are reported as the mean ± standard deviation (M ± SD) for continuous measures and frequency and percentage (%) for all categorical variables. The normality of distribution was

TABLE 1 | Descriptive statistics for the whole sample subdivided by HCWs and non-HCWs.

Variable	HCWs 59		Non-HCWs 88			
	Mean	SD	Mean	SD	t-test	p
Age (years)	46.0	(8.9)	44.0	(10.0)		n.s.
BMI (kg/m^2)	24.0	(5.4)	24.5	(4.5)		n.s.
WC (cm)	86.8	(11.2)	83.7	(10.7)		n.s.
MD Score	35.8	(4.7)	34.1	(3.7)	2.3	<0.05
Total cholesterol (mg/dl)[a]	191.6	(32.8)	180.5	(25.8)	2.3	<0.05
HDL-cholesterol (mg/dl)[a]	66.3	(17.5)	66.4	(15.3)		n.s.
LDL-cholesterol (mg/dl)[a]	107.1	(31.1)	109.8	(29.4)		n.s.
TG (mg/dl)	94.7	(44.8)	75.7	(31.4)	2.8	<0.05
FBG (mg/dl)	81.5	(9.4)	84.4	(11.3)		n.s.
SBP (mmHg)[b]	114.2	(16.0)	110.9	(14.2)		n.s.
DBP (mmHg)[b]	72.4	(9.7)	71.6	(10.2)		n.s.

[a] *The averages for total cholesterol, LDL and HDL Were calculated only considering subjects who were not on therapy for hypercholesterolemia.*

[b] *The averages for SBP and DBP were calculated only for subjects who were not on therapy for hypertension.*

BMI, body mass index; WC, waist circumference; TG, triglycerides; FBG, fasting blood glucose; SBP, systolic blood pressure; DBP, diastolic blood pressure; n.s., not significant.

assessed for each variable using Shapiro's test. Comparisons of the means of the continuous variables between HCWs and non-HCWs were performed with Student's *t*-test for independent samples. Comparisons of the means of the continuous variables of the stratified women workers based on menopause were performed with ANOVA. Comparisons of the categorical variables were performed with the χ^2 test. The averages of total cholesterol, LDL, HDL, TG, SBP and DBP were calculated only for subjects who were not on therapy for hypertension or hypercholesterolemia.

Correlation tests were performed with Pearson's test. A multivariate logistic regression test was performed to calculate the odds ratio (OR). UNIANOVA univariate linear analysis models or two-way variance tests permitted evaluation of the effect of two combined experimental factors to highlight possible interaction effects. By interaction effect, we mean the phenomenon whereby the effect of one factor changes depending on the level of the other factor. A p-value ≤ 0.05 was considered statistically significant, with a 95% confidence interval, and p-values not statistically significant are shown in the tables as "n.s." All analyses were performed using SPSS Statistics Software.

TABLE 2 | Comparison between the mean score for each food category included in the Mediterranean diet in the HCW and non-HCW groups.

	HCWs		Non-HCWs			
Score	**Mean**	**SD**	**Mean**	**SD**	**t-test**	**p**
Cereals	4.5	(0.5)	4.7	(0.8)		n.s.
Potatoes	3.1	(1.6)	1.0	(1.1)	8.7	<0.001
Fruits	4.6	(0.9)	4.8	(0.7)		n.s.
Vegetables	4.6	(0.9)	4.6	(0.8)		n.s.
Legumes	3.5	(1.6)	1.8	(1.0)	7.3	<0.001
Fish	3.8	(1.3)	1.5	(0.9)	11.9	<0.001
Red meat products and eggs*	1.1	(1.4)	2.0	(1.4)	−3.7	<0.001
Poultry*	1.3	(1.4)	3.3	(1.0)	−9.5	<0.001
Cheese. yogurt and milk*	0.7	(1.4)	0.7	(1.5)		n.s.
EVOO	4.6	(0.9)	4.6	(0.9)		n.s.
Alcohol*	3.9	(1.7)	4.8	(0.7)	−3.7	<0.001

**lower scores correspond to more frequent consumption, considered less adherent to the Mediterranean diet.*
EVOO, extra-virgin olive oil; n.s., not significant.

RESULTS

The whole sample ($N = 147$) featured a majority of non-HCWs ($N = 88$). **Table 1** summarizes the general, anthropometric and metabolic laboratory parameters of the enrolled subjects, expressed as the mean ± SD, for continuous variables and as percentages (%) for proportions. Age, WC and BMI averages were not significantly different between the two groups. HCWs showed significantly greater MD scores and total cholesterol and TG serum levels but no significant differences in other clinical variables measured [HDL- and LDL-cholesterol serum levels, fasting blood glucose, diastolic and systolic blood pressure (DBP, SBP)]. Regarding each group of foods, HCWs showed higher intake of potatoes, legumes and fish ($p < 0.001$) than non-HCWs. Additionally, HCWs consumed significantly higher quantities of red meat and its derivatives, white meat (poultry) and alcoholic beverages ($p < 0.001$) (**Table 2**).

The correlation analysis matrix for the whole sample (**Table 3**) showed significant inverse associations between the MD score and LDL cholesterol ($p < 0.05$) and between EVOO consumption and LDL cholesterol ($p < 0.01$). Significant positive correlations were found between TG serum level and age, BMI, and WC ($p < 0.001$). The same patterns were also found for LDL cholesterol, fasting blood glucose, DBP and SBP.

In the multivariate logistic regression model, LDL cholesterol level > 116 mg/dl was set as the dependent variable, and work category, MD Score > 35, EVOO consumption >/= 5 servings per week (1 serving = 25 ml) were set as the independent variables. The above model showed that LDL cholesterol levels were positively influenced by menopausal status (OR = 2.264, 95% CI 1.045–4.907; $p = 0.038$) and negatively influenced by EVOO consumption (OR = 0.280, 95% CI 0.104–0.759; $p = 0.012$).

TABLE 3 | Correlation matrix for continuous variables across the entire study population.

	HCWs + Non-HCWs ($n = 147$)									
	TG (mg/dl)		**LDL-cholesterol (mg/dl)**		**FBG (mg/dl)**		**SBP (mmHg)**		**DBP (mmHg)**	
	r	**p**	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**
Age (years)	0.27	<0.001	0.28	<0.01	0.21	<0.01	0.43	<0.001	0.34	<0.001
BMI (kg/m^2)	0.28	<0.001	0.15	<0.05	0.25	<0.001	0.33	<0.001	0.36	<0.001
WC (cm)	0.34	<0.001	0.17	<0.05	0.23	<0.05	0.33	<0.001	0.33	<0.001
EVOO Score	−0.01	n.s.	−0.20	<0.01	−0.12	n.s.	−0.02	n.s.	−0.10	n.s.
MD Score	0.03	n.s.	−0.18	<0.05	−0.05	n.s.	0.06	n.s.	−0.04	n.s.

BMI, body mass index; WC, waist circumference; EVOO, extra-virgin olive oil; MD Score, Mediterranean diet score; TG, triglycerides; FBG, fasting blood glucose; SBP, systolic blood pressure; DBP, diastolic blood pressure; n.s., not significant.

Differences in categorical variables between the two groups are shown in **Table 4**. The HCW group included greater numbers of subjects with menopausal status, with hypertension and with hypertriglyceridemia ($p < 0.05$) than the non-HCW group.

UNIANOVA analysis was used to assess whether the type of work (healthcare or non-healthcare) or menopausal status could have any effect, singly or in combination, on SBP, DBP, circulating LDL cholesterol, TG serum levels, and fasting blood glucose. We found that menopause had a significant effect on SBP, DBP, LDL cholesterol and blood sugar, regardless of the type of work performed. Higher TG serum levels in HCWs were found to be affected both by menopausal status and type of job (**Table 5**).

DISCUSSION

This study shows that HCWs are more MD-adhering than are non-HCWs, as demonstrated by the higher average MD score, implying protection against major non-communicable diseases, perhaps due to their professional knowledge. Despite being arithmetically close, the two averages were significantly different (mean difference 1.7, CI 95% −3.2 to −0.4, $p = 0.012$), likely due to the limited dispersion of MD score values relative to the average, as documented by the relatively low standard deviations in both groups.

Surprisingly, HCWs showed significantly higher total cholesterol and triglyceride serum levels, likely related to their higher consumption of red meat and its derivatives, eggs, and alcoholic beverages, all foods capable of interfering with lipid metabolism and, probably, of counteracting the beneficial effects of foods more adherent to the MD.

The higher alcohol consumption found in the HCW group opens a very interesting research area with the intent of verifying the hypothesis of alcohol use as a potential sensitive indicator of the level of work-related stress (33), a topic that does not actually fall within our main goals.

Corroborating the internal validity of our study, subjects with higher age, BMI and abdominal circumference (WC) exhibited higher circulating TG, LDL cholesterol, fasting blood glucose serum level, and blood pressure. Indeed, it is well-known that age, excess weight and visceral adiposity can contribute to increase risks of hypertriglyceridemia, hypercholesterolemia, diabetes and hypertension (34). In addition, our study confirms that even in Mediterranean countries, especially in southern Italy, where EVOO consumption is a common everyday practice, there is better control of LDL cholesterol levels in subjects who follow this custom more closely (35, 36).

Furthermore, the HCW group, including a larger number of subjects in menopause, stands out for higher levels of TG. In this regard, the multivariate logistic regression model and the analysis of two-way variance highlighted that the condition of menopause exerts strong effects on all metabolic fluid biomarkers investigated. In particular, our analyses reveal that menopausal status has a significant adverse effect on TG levels among HCWs. This finding confirms previous evidence supporting the capability of menopause to induce, especially during the transition period, significant metabolic changes that

TABLE 4 | Comparison of categorical variables between the HCW and non-HCW groups.

	HCWs ($n = 59$)		Non-HCWs ($n = 88$)			
	n	%	n.	%	χ^2	p
Menopause	22	(37)	20	(23)	0.95	<0.05
LDL-cholesterol > 116 mg/dl[a]	21	(36)	28	(32)	0.2	n.s.
Treatment for hypercholesteremia	7	(12)	5	(6)	3.0	n.s.
SBP >130 mm Hg and/or DBP >85 mm Hg[b]	6	(10)	3	(3)	2.9	n.s.
Treatment for hypertension	8	(14)	3	(3)	5.9	<0.05
TG > 150 mg/dl	9	(15)	4	(5)	4.8	<0.05

[a] *Subjects under treatment for hypercholesterolemia were not included.*
[b] *Subjects under treatment for hypertension were not included.*
SBP, systolic blood pressure; DBP, diastolic blood pressure; TG, triglycerides; n.s., not significant.

TABLE 5 | UNIANOVA for the analysis of variance in fluid biomarkers between the two groups (HCWs and non-HCWs), further subdivided according to menopausal status, and evaluation of the single or combined effects of job and menopause as confounders.

Job	HCWs ($n = 59$)				Non-HCWs ($n = 88$)									
Menopause	Yes ($n = 22$)		No ($n = 37$)		Yes ($n = 20$)		No ($n = 68$)		Menopause effect		Job effect		Job* Menopause effect	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.	F	p	F	p	F	p
SBP (mm Hg)[b]	121.3	16.5	111.4	13.9	121.6	10.1	108.0	13.8	25.6	<0.01		n.s.		n.s.
DBP (mm Hg)[b]	73.4	11.3	71.9	8.5	76.7	6.4	70.2	10.4	4.3	<0.05		n.s.		n.s.
LDL cholesterol (mg/dl)[a]	125.3	25.5	98.3	32.5	124.7	41.6	106	24.8	14.0	<0.01		n.s.		n.s
TG (mg/dl)	118.2	48.0	77.7	33.2	81.7	32.7	71.6	28.5	16.3	<0.01	11.6	<0.01	5.9	<0.05
FBG (mg/dl)	87.1	9.8	78.2	7.4	87.9	15.1	83.4	10.0	12.2	<0.01		n.s.		n.s.

[a] *The averages for total cholesterol, LDL and HDL were calculated only considering subjects who were not being treated for hypercholesterolemia.*
[b] *The averages for SBP and DBP were calculated only for subjects who were not being treated for hypertension.*
TG, triglycerides; FBG, fasting blood glucose; SBP, systolic blood pressure; DBP, diastolic blood pressure; n.s., not significant.

may persist even in late life. Elevated blood lipids, especially LDL cholesterol serum levels, have been recently recorded in both cross-sectional and longitudinal settings (37). In addition, the lack of estrogen and progesterone, characteristic of menopause, contributes to an increase in blood pressure and an increase in overall cardiovascular risk (38).

Some limitations of this study should be considered. Because of the cross-sectional approach, it has not been possible to establish the direction of any causal relationship, so our data provide a description rather than an explanation. Prospective studies are needed to clarify causal relationships. In addition, we failed to collect further data on other determinants that may influence the eating habits and metabolic status of female workers, such as marital status, number of children, physical activity, and work-related stress. It would also be interesting to assess shift workers to test whether their eating habits and lifestyle are influenced by work organization and, above all, by night work.

Finally, the choice of defining the state of menopause in the anamnestic phase as authoritatively proposed recently by Nelson (30), without hormonal dosage, may have compromised the methodological accuracy. However, this choice was driven by the intent of facilitating the application of this health-promotion protocol during the periodic health surveillance of workers, avoiding proposing the administration of hormonal doses that may influence the sensitivity of workers, as well as the requirement of more complex and therefore fairly expensive laboratory techniques.

It also should be noted that, although the limited sample size, the study subjects were selected in such a way that the two groups were as homogeneous as possible. In particular, the two groups of female workers were homogeneous in terms of various characteristics capable of influencing metabolic status and lifestyles (age, level of education, WC, BMI). Therefore, HCW and non-HCW groups are adequately comparable to ensure a proper statistical analysis of the results. Moreover, according to the formula proposed by Viechtbauer et al., a minimum sample size of 58 subjects is required to perform pilot studies using a 95% confidence interval. The sample under study consisting of 147 female workers, therefore, should be adequate to perform a proper statistical analysis (39) however we propose to enlarge the sample for further studies.

CONCLUSIONS AND PRATICAL IMPLICATIONS

HCWs are more adherent to a MD than are non-HCWs, possibly due to greater knowledge of healthy principles related to this dietary pattern. Despite this, HCWs showed higher serum concentrations of triglycerides and total cholesterol. Both menopausal status and type of work were linked to higher TG levels among HCWs.

According to the results of the study, the main area of intervention is represented by periodic health surveillance in which the occupational physician will have to propose to the female workers clear and personalized indications on the qualitative and quantitative composition of the diet, also in consideration of the energy expenditure required to carry out the specific tasks.

Periodic health surveillance is also an opportunity to better investigate alcohol consumption and look for possible associations with work-related stress factors. This topic could be the subject of future studies.

Recent scientific evidence confirms the importance of gender medicine also in the field of occupational medicine. In fact, our results show that the menopause has significant effects on the metabolism and cardiovascular system in women. It is therefore necessary for occupational physicians to develop health promotion programmes specifically aimed at women to counteract the menopausal effects on their health.

In addition, to help female workers correct their blood levels of TG and Total Cholesterol, public institutions and private companies should promote their physical activity by entering into agreements with gyms or sports centers and, where possible, by creating jogging and/or walking routes within the company perimeter or by providing suitable company premises with sports equipment (e.g., treadmills and/or exercise bikes). In addition, employers of companies with workplace canteens should require catering companies to provide nutritionally balanced menus, indicating the calories and nutrients in each dish. Another useful intervention would be to introduce low-calorie drinks and snacks in vending machines that are free or low in refined sugars and/or saturated fats and/or salt, respectively. All these interventions should be agreed with the occupational physician and shared with the workers' safety representatives.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the National Cancer Research Center Giovanni Paolo II, Bari, Italy (ClinicalTrials.gov, Identifier: NCT04596358). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LDi: conceptualization, visualization, and project administration. AP and LV: methodology. AP: software and formal analysis. GD and LV: validation. NM and LL: investigation. GD: resources and supervision. AP, AC, and LDe: data curation. RZ, AP, AC, and LDe: writing—original draft preparation. LDi and GD: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

REFERENCES

1. Menotti A, Kromhout D, Blackburn H, Fidanza F, Buzina R, Nissinen A. Food intake patterns and 25-year mortality from coronary heart disease: cross-cultural correlations in the seven countries study. *Eur J Epidemiol.* (1999) 15:507–15. doi: 10.1023/A:1007529206050
2. Fidanza F. Who remembers the true Italian Mediterranean diet? *Diabetes Nutr Metab.* (2001) 14:119–20.
3. Alberti-Fidanza A, Fidanza F, Chiuchiù MP, Verducci G, Fruttini D. Dietary studies on two rural Italian population groups of the seven countries study. 3. Trend of food and nutrient intake from 1960 to 1991. *Eur J Clin Nutr.* (1999) 53:854–60. doi: 10.1038/sj.ejcn.1600865
4. D'Alessandro A, De Pergola G. Mediterranean diet pyramid: a proposal for Italian people. *Nutrients.* (2014) 6:4302–16. doi: 10.3390/nu6104302
5. De Pergola G, Martino T, Zupo R, Caccavo D, Pecorella C, Paradiso S, et al. 25 Hydroxyvitamin D levels are negatively and independently associated with fat mass in a cohort of healthy overweight and obese subjects. *Endocr Metabol Immun Disord Drug Targets.* (2019) 19:838–44. doi: 10.2174/1871530319666190122094039
6. Zupo R, Lampignano L, Lattanzio A, Mariano F, Osella AR, Bonfiglio C, et al. Association between adherence to the Mediterranean diet and circulating vitamin D levels. *Int J Food Sci Nutr.* (2020) 71:1–7. doi: 10.1080/09637486.2020.1744533
7. De Pergola G, D'Alessandro A. Influence of Mediterranean diet on blood pressure. *Nutrients.* (2018) 10:1170. doi: 10.3390/nu10111700
8. Schwingshackl L, Krause M, Schmucker C, Hoffmann G, Rücker G, Meerpohl JJ. Impact of different types of olive oil on cardiovascular risk factors: a systematic review and network meta-analysis. *Nutr Metabol Cardiovasc Dis.* (2019) 29:1030–39. doi: 10.1016/j.numecd.2019.07.001
9. Uusitupa M, Khan TA, Viguiliouk E, Kahleova H, Rivellese AA, Hermansen K, et al. Prevention of type 2 diabetes by lifestyle changes: a systematic review and meta-analysis. *Nutrients.* (2019) 11:2611. doi: 10.3390/nu11112611
10. D'Alessandro A, De Pergola G. Mediterranean diet and cardiovascular disease: a critical evaluation of a priori dietary indexes. *Nutrients.* (2015) 7:7863–88. doi: 10.3390/nu7095367
11. Salas-Salvadó J, Becerra-Tomás N, García-Gavilán JF, Bulló M, Barrubés L. Mediterranean diet and cardiovascular disease prevention: what do we know? *Progr Cardiovasc Dis.* (2018) 61:62–7. doi: 10.1016/j.pcad.2018.04.006
12. D'Alessandro A, De Pergola G, Silvestris F. Mediterranean diet and cancer risk: an open issue. *Int J Food Sci Nutr.* (2016) 67:593–605. doi: 10.1080/09637486.2016.1191444
13. Hernáez Á, Castañer O, Goday A, Ros E, Pintó X, Estruch R, et al. The Mediterranean diet decreases LDL atherogenicity in high cardiovascular risk individuals: a randomized controlled trial. *Mol Nutr Food Res.* (2017) 61:1601015. doi: 10.1002/mnfr.201601015
14. Moreno LA, Sarría A, Popkin BM. The nutrition transition in Spain: a European Mediterranean country. *Eur J Clin Nutr.* (2002) 56:992–1003. doi: 10.1038/sj.ejcn.1601414
15. Genin PM, Dessenne P, Finaud J, Pereira B, Dutheil F, Thivel D, et al. Effect of work-related sedentary time on overall health profile in active vs. inactive office workers. *Front Public Health.* (2018) 6:279. doi: 10.3389/fpubh.2018.00279
16. Scapellato ML, Comiati V, Buja A, Buttignol G, Valentini R, Burati V, et al. Combined before-and-after workplace intervention to promote healthy lifestyles in healthcare workers (STI-VI study): short-term assessment. *Int J Environ Res Public Health.* (2018) 15:2053. doi: 10.3390/ijerph15092053
17. Di Lorenzo L, Pipoli A, Manghisi NM, Clodoveo ML, Corbo F, De Pergola G, et al. Nutritional hazard analysis and critical control points at work (NACCPW): interdisciplinary assessment of subjective and metabolic work-related risk of the workers and their prevention. *Int J Food Sci Nutr.* (2020) 71:1–7. doi: 10.1080/09637486.2020.1750572
18. Watanabe M, Risi R, De Giorgi F, Tuccinardi D, Mariani S, Basciani S, et al. Obesity treatment within the Italian national healthcare system tertiary care centers: what can we learn? *Eat Weight Disord.* (2020) 26:771–8. doi: 10.1007/s40519-020-00936-1
19. Bonaccio M, Di Castelnuovo A, Bonanni A, Costanzo S, De Lucia F, Persichillo M, et al. Decline of the Mediterranean diet at a time of economic crisis. Results from the moli-sani study. *Nutr Metabol Cardiovasc Dis.* (2014) 24:853–60. doi: 10.1016/j.numecd.2014.02.014
20. Vitale M, Bianchi MA, Rapetti V, Pepe JM, Giacco A, Giacco R, et al. A nutritional intervention programme at a worksite canteen to promote a healthful lifestyle inspired by the traditional Mediterranean diet. *Int J Food Sci Nutr.* (2018) 69:117–24. doi: 10.1080/09637486.2017.1336515
21. Pietroiusti A, Neri A, Somma G, Coppeta L, Iavicoli I, Bergamaschi A, et al. Incidence of metabolic syndrome among night-shift healthcare workers. *Occup Environ Med.* (2010) 67:54–7. doi: 10.1136/oem.2009.046797
22. Yu E, Rimm E, Qi L, Rexrode K, Albert CM, Sun Q, et al. Diet, lifestyle, biomarkers, genetic factors, and risk of cardiovascular disease in the nurses' health studies. *Am J Public Health.* (2016) 106:1616–23. doi: 10.2105/AJPH.2016.303316
23. Juárez-Pérez CA, Aguilar-Madrid G, Haro-García LC, Gopar-Nieto R, Cabello-López A, Jiménez-Ramírez C, et al. Increased cardiovascular risk using atherogenic index measurement among healthcare workers. *Arch Med Res.* (2015) 46:233–9. doi: 10.1016/j.arcmed.2015.03.002
24. Sasser AC, Rousculp MD, Birnbaum HG, Oster EF, Lufkin E, Mallet D. Economic burden of osteoporosis, breast cancer, and cardiovascular disease among postmenopausal women in an employed population. *Womens Health Issues.* (2005) 15:97–108. doi: 10.1016/j.whi.2004.11.006
25. Ulhôa MA, Marqueze EC, Burgos LGA, Moreno CRC. Shift work and endocrine disorders. *Int J Endocrinol.* (2015) 2015:826249. doi: 10.1155/2015/826249
26. O'Neil A, Scovelle AJ, Milner AJ, Kavanagh A. Gender/sex as a social determinant of cardiovascular risk. *Circulation.* (2018) 137:854–64. doi: 10.1161/CIRCULATIONAHA.117.028595
27. Whelton PL, Carey RM, Aronow WS, Casey DE, Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on clinical practice guidelines. *J Am Coll Cardiol.* (2018) 71:e127–248.
28. Arnett DK, Blumenthal RS, Albert MA, Buroker AB, Goldberger ZD, Hahn EJ, et al. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: executive summary: a report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. *Circulation.* (2019) 140:e563–95. doi: 10.1161/CIR.0000000000000677
29. Ulijaszek SJ. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. WHO technical report series 894. Pp. 252. (World Health Organization, Geneva, 2000.) SFr 56.00, ISBN 92-4-120894-5, paperback. *J Biosoc Sci.* (2003) 35:624–5. doi: 10.1017/S0021932003245508
30. Nelson HD. Menopause. *Lancet.* (2008) 371:760–70. doi: 10.1016/S0140-6736(08)60346-3
31. Panagiotakos DB, Polystipioti A, Papairakleous N, Polychronopoulos E. Long-term adoption of a Mediterranean diet is associated with a better health status in elderly people; a cross-sectional survey in Cyprus. *Asia Pac J Clin Nutr.* (2007) 16:331–7.
32. Zaragoza-Martí A, Cabañero-Martínez MJ, Hurtado-Sánchez JA, Laguna-Pérez A, Ferrer-Cascales R. Evaluation of Mediterranean diet adherence scores: a systematic review. *BMJ Open.* (2018) 8:e019033. doi: 10.1136/bmjopen-2017-019033
33. Ruotsalainen JH, Verbeek JH, Mariné A, Serra C. Preventing occupational stress in healthcare workers. *Cochrane Database Syst Rev.* (2015) CD002892. doi: 10.1002/14651858.CD002892.pub5
34. Consultation WHO. *Obesitiy: Preventing and Managing the Global Epidemic.* Washington, DC: World Health Organization. (2000).
35. Franconi F, Campesi I, Romani A. Is extra virgin olive oil an ally for women's and men's cardiovascular health? *Cardiovasc Ther.* (2020) 2020:6719301. doi: 10.1155/2020/6719301
36. Tsartsou E, Proutsos N, Castanas E, Kampa M. Network meta-analysis of metabolic effects of olive-oil in humans shows the importance of olive oil consumption with moderate polyphenol levels as part of the Mediterranean diet. *Front Nutr.* (2019) 6:6. doi: 10.3389/fnut.2019.00006
37. Wang Q, Ferreira DLS, Nelson SM, Sattar N, Ala-Korpela M, Lawlor DA. Metabolic characterization of menopause: cross-sectional and

longitudinal evidence. *BMC Med*. (2018) 16:17. doi: 10.1186/s12916-018-1008-8
38. Mattioli AV, Sciomer S, Moscucci F, Maiello M, Cugusi L, Gallina S. et al. Cardiovascular prevention in women: a narrative review from the Italian society of cardiology working groups on "cardiovascular prevention, hypertension and peripheral circulation" and on "women disease." *J Cardiovasc Med*. (2019) 20:575–83. doi: 10.2459/JCM.0000000000000831
39. Viechtbauer W, Smits L, Kotz D, Budé L, Spigt M, Serroyen J, et al. A simple formula for the calculation of sample size in pilot studies. *J Clin Epidemiol*. (2015) 68:1375–9. doi: 10.1016/j.jclinepi.2015.04.014

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