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# Workplace and employee health in the post-pandemic world; strategies, risks, and challenges

**Edited by**
Muhammad Salman Shabbir, Kamran Azam, Ahmed Faisal Imtiaz Siddiqi, Arshad Mahmood and Rabia Salman

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# Workplace and employee health in the post-pandemic world; strategies, risks, and challenges

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Arshad Mahmood — University of Science Malaysia (USM), Malaysia
Rabia Salman — University of Science Malaysia (USM), Malaysia

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EDITED BY
Francesco Chirico,
Catholic University of the Sacred Heart, Italy

REVIEWED BY
Alberto Modenese,
University of Modena and Reggio Emilia, Italy
Francesca Larese Filon,
University of Trieste, Italy

*CORRESPONDENCE
Alexia Schmid
alexia.schmid@unifr.ch

†These authors have contributed equally to this work and share first authorship

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# SARS-CoV-2 infection among employees working from home and on site: An occupational study in Switzerland

Alexia Schmid[1*†], Daniela Anker[2†], Julie Dubois[1], Isabelle Bureau-Franz[3], Nathalie Piccardi[3], Sara Colombo Mottaz[3], Stéphane Cullati[2,4], Arnaud Chiolero[2,5,6] and Pierre-Yves Rodondi[1] on behalf of the Corona Immunitas Research Group

[1]Institute of Family Medicine, Faculty of Science and Medicine, University of Fribourg, Fribourg, Switzerland, [2]Population Health Laboratory #PopHealthLab, Faculty of Science and Medicine, University of Fribourg, Fribourg, Switzerland, [3]Nestlé Research, Lausanne, Switzerland, [4]Department of Readaptation and Geriatrics, University of Geneva, Geneva, Switzerland, [5]Institute of Primary Health Care, Faculty of Medicine (BIHAM), University of Bern, Bern, Switzerland, [6]School of Population and Global Health, Faculty of Medicine and Health Sciences, McGill University, Montréal, QC, Canada

During the COVID-19 pandemic, many companies implemented working from home to mitigate the spread of the disease among their employees. Using data from *Corona Immunitas Nestlé*, a seroepidemiological study conducted among employees from two Nestlé sites in Switzerland, we aimed to investigate whether there was a difference in SARS-CoV-2 infection rates between employees working most of the time from home and employees mobilized in a workplace equipped with a specialized occupational safety unit and strict sanitary measures. We also investigated whether this association was modified by household size, living with children, vulnerability, worries about an infection, and worries about adverse health consequences if infected. Data were collected between 8 December 2020, and 11 February 2021. Previous SARS-CoV-2 infections were ascertained by the presence of anti-SARS-CoV-2 IgG antibodies in the blood. Of the 425 employees included (53% women; mean age 42 years ranging between 21 and 64 years), 37% worked most of the time from home in 2020 and 16% had been infected with SARS-CoV-2. Participants who worked most of the time from home in 2020 had slightly higher odds of being infected with SARS-CoV-2 compared to participants who never or only sometimes worked from home (adjusted OR 1.29, 95% CI 0.73–2.27). The association was stronger in participants living alone or with one other person (adjusted OR 2.62, 95% CI 1.13–6.25). Among participants living with two or more other persons (adjusted OR 0.66, 95% CI 0.30–1.39) and among vulnerable participants (adjusted OR 0.53, 95% CI 0.13–1.93), working from home tended to be associated with lower odds of infection. In conclusion, in a context of strict sanitary measures implemented in the workplace, employees working from home did not seem to be at lower risk of infection compared to those working on site, especially if living alone or with one other person.

KEYWORDS

**occupational health, SARS-CoV-2 infection (COVID-19), COVID-19, workplace, employees, work from home**

# Introduction

The Coronavirus disease (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), had an immense impact on work environments with the implementation of sanitary measures and restrictions at workplaces. Many companies implemented working from home as well as strict sanitary measures in the workplace to mitigate the spread of SARS-CoV-2 among their employees (1–4). Compared to working from home, working on site may place employees at increased risk for SARS-CoV-2 infection due to potential exposure to infected individuals on the way to work and in the workplace, e.g., through potentially close proximity in enclosed spaces (2, 3, 5). The risk of infection, however, also depends on the exposure to SARS-CoV-2 outside of the workplace, which is probably related to the social contacts a person had. Indeed, a population-based study conducted among the Swiss population suggested that living with children was associated with SARS-CoV-2 seropositivity (6), and in a case-control study by Galmiche et al., a higher risk of infection was reported in larger households and in households with children (7). A meta-analysis by Madewell et al. indicated that households are important sites contributing to SARS-CoV-2 transmission (8).

Therefore, we aimed to investigate whether employees working from home and employees mobilized in a workplace with strict sanitary measures had different SARS-CoV-2 infection rates. Further, we investigated whether this difference would change depending on employees' social contacts, i.e., household size and number of children, as well as their level of worries about an infection and their vulnerability [defined according to the criteria of the Federal Office of Public Health in Switzerland (9)].

Using data from a seroepidemiological study conducted among employees from two Nestlé sites with strict sanitary measures implemented in the workplace, the specific objectives were to investigate:

- The proportion of employees having been infected with SARS-CoV-2.
- Whether SARS-CoV-2 infection rates differed between employees working from home and those on site.
- Whether people living in households with fewer people and without children had fewer infections when working from home.
- Whether vulnerable people or people worried about an infection had fewer infections when working from home.

# Materials and methods

This manuscript was written using the *Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies* (10).

## Study design and participants

We used data from the study *Corona Immunitas Nestlé*, which was part of *Corona Immunitas (https://www.corona-immunitas.ch/en/)*, a Swiss national research program of seroepidemiological studies conducted during the COVID-19 pandemic and coordinated by the Swiss School of Public Health (SSPH+; https://ssphplus.ch/) (11). *Corona Immunitas Nestlé* was conducted among employees from two Nestlé sites in Switzerland, a research center (Lausanne, $n = 920$) and a factory (Romont, $n = 390$). These sites were selected because the scope of their activities required the presence of employees in the workplace. All employees aged 18 years and older working at the two specific sites were invited by e-mail to participate ($n_{tot} = 1{,}310$). Study visits were carried out by Nestlé trained medical staff on work sites. Venous blood samples and questionnaire data were collected between December 8, 2020, i.e., during the descending phase of the second pandemic wave in Switzerland, and February 11, 2021, i.e., at the lowest case number between the second and third pandemic waves (Figure 1). At the time of this study, no vaccine against SARS-CoV-2 was available in Switzerland, and therefore, antibody positivity among participants was related to previous infection only.

Switzerland has sought to find a balance between controlling the propagation of COVID-19 and maintaining a certain normality in social and economic life. A complete lockdown consisting of staying home on legal orders has never occurred. Sanitary measures were most restrictive during the first pandemic wave from March to May 2020, when schools, most businesses, and facilities were closed. Companies were invited to have their employees working from home, whenever possible. The second wave, at the end of October 2020, resulted in a more heterogeneous response with fewer restrictions, with each canton having the role of making decisions (12, 13).

Since the beginning of the pandemic in Switzerland (March 2020), the two Nestlé sites have implemented strict sanitary measures in the workplace as well as work from home for employees whose work could be performed remotely. Implemented sanitary measures were for example: temperature control at the entry of the buildings, mandatory wearing of sanitary masks, environmental adjustments to enable physical distance, and surveillance measures, e.g. regular COVID-19 testing. In addition, employees were divided into groups that

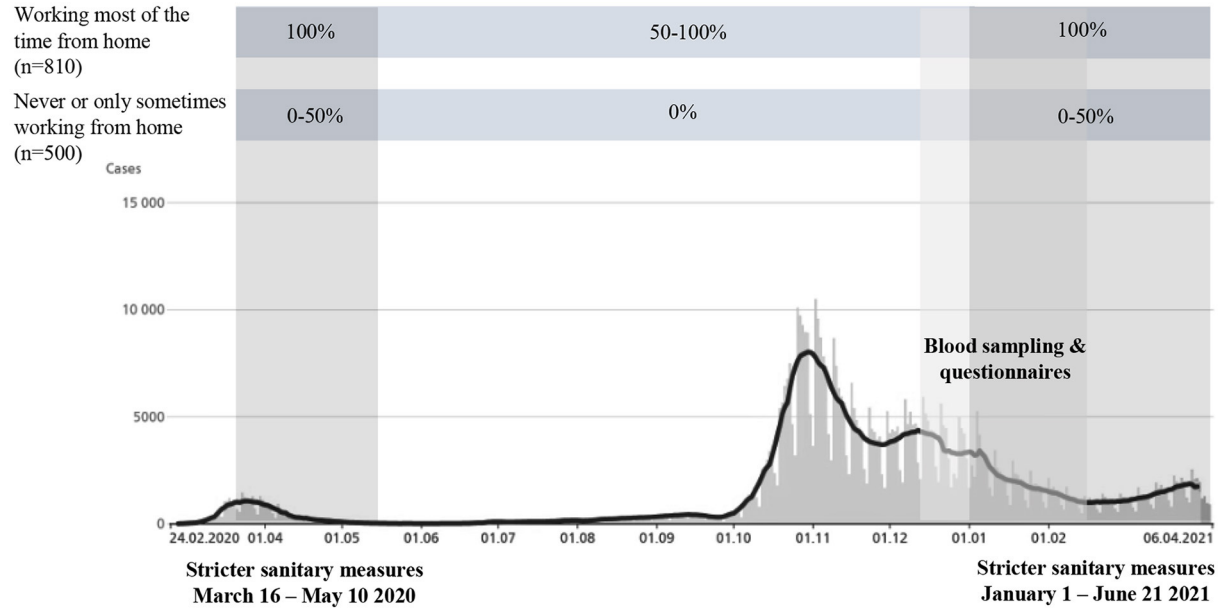


FIGURE 1
Time percentage of work from home among employees in the Nestlé company classified into two exposure groups (*working most of the time from home* and *never or only sometimes working from home*) over time and in relation to the COVID-19 pandemic and the *Corona Immunitas Nestlé* study. The graph shows the laboratory-confirmed cases in Switzerland from 24.02.2020 to 06.04.2021, in absolute case numbers. It is important to note that the number of tests performed has increased over time, since only hospitalized at-risk persons were tested in the beginning of the pandemic (34). *n* = number of employees invited to participate in the study. Figure adapted from Schmid et al. (35).

could not be in the workplace at the same time to further reduce the risks of virus transmission. These measures were maintained during the whole duration of this study, however, with stricter measures implemented during the first wave of the pandemic in spring 2020, from March 16 to May 10, and again starting January 1, 2021.We distinguished two groups of employees subject to different measures (Figure 1). At the research center, 80% of employees ($n = 720$) worked entirely from home in spring 2020, and then partially on site until December 2020, and 20% ($n = 200$) continued to work on site to ensure business continuity. At the factory, 75% of employees ($n = 300$) worked part-time on site in spring 2020 and fulltime until December 2020 due to their involvement in the factory production. The remaining employees were those who only performed administrative tasks (25%, $n = 90$) and worked fulltime from home since the beginning of the pandemic and throughout the period covered by this study.

## Serology analysis

Venous blood samples (5 ml per participant) were collected and transported to the Lausanne University Hospital (CHUV) the same day. Blood analyses were performed using the SenASTrIS (Sensitive Anti-SARS-CoV-2 Spike Trimer Immunoglobulin Serological) test developed by the CHUV, the Swiss Federal Institute of Technology in Lausanne (EPFL) and the Swiss Vaccine Center (14). The Luminex binding assay measured binding of IgG antibodies to the trimeric SARS-CoV-2 S-protein. According to the test developers, participants were positive for SARS-CoV-2 antibodies if the antibody response was equal or above the cut-off of six, negative below the cut-off of four, and indeterminate in between. The specificity and sensitivity of 99.7 and 96.6%, respectively, from 15 days after a SARS-CoV-2 infection were defined on a population-based sample, hence limiting spectrum bias (11, 15).

## Questionnaire

Questionnaires were completed online by the participants during the study visit. The *Corona Immunitas Nestlé* questionnaire was based on the *Corona Immunitas* baseline questionnaire (available in the published protocol (11)), and included information about health status, sociodemographic data, household characteristics and worries about the coronavirus situation. A specific section was added for this study to assess working from home.

## Variables of interest

The exposure of interest was working from home, ascertained by the question "have you been concerned by working from home during the first wave of the pandemic (March 16 to May 10)?" to which participants replied either "yes, most of the time," "yes, but only sometimes," or "no." It allowed us to determine the working conditions of the participants in spring 2020 and from there, we assumed how the participants worked during the rest of the year given the above-described work organization implemented by the two Nestlé sites. Two exposure groups were defined: (1) participants who were *most of the time working from home in 2020;* we considered that participants who reported working most of the time from home during spring 2020 also worked either full time or minimum 50% from home until winter 2020-2021, (2) participants who were *never or only sometimes working from home in 2020*; we considered that participants who reported never or only sometimes working from home during spring 2020 fully worked on site until winter 2020–2021 (Figure 1). Although strongly mobilized on site, we considered the second group to have a moderate exposure to SARS-CoV-2 in the workplace because the company implemented strict sanitary measures to reduce SARS-CoV-2 exposure.

The outcome variable was the presence of IgG antibodies against SARS-CoV-2 in the blood considered as a proxy for having been infected with the virus at least once since the beginning of the pandemic. We considered that participants with a positive serology result had been infected, and those with a negative or indeterminate result had not been infected since the beginning of the pandemic. At the time of this study, vaccination against SARS-CoV-2 was not yet available in Switzerland.

Potential confounders were identified using a directed acyclic graph (Supplementary Figure 1) and included age, gender, education, work site and vulnerability. Potential effect modifiers of the association between working from home and SARS-CoV-2 infection included household size, living with children, vulnerability, worries about an infection, and worries about adverse health consequences if infected. Age was grouped into three categories *18–34; 35–49; 50–65* years. Education was grouped into a *basic educational level* (mandatory education, apprenticeship or Matura) and an *advanced educational level* (technical college, university or polytechnic).

Participants were considered vulnerable, i.e., having a condition that increases their risk of developing a severe form of COVID-19, in case of a self-reported pregnancy, obesity, or a diagnosis of cancer, diabetes, hypertension, cardiovascular disease, chronic respiratory disease or a disease that weaken the immune system, or the intake of a treatment that weaken the immune system (as defined by the Federal Office of Public Health in Switzerland (9)). Obesity was defined by a BMI above 30 kg/m$^2$, calculated from self-reported weight and height. A participant was considered *vulnerable* when concerned by at least one vulnerability criterion.

Household size was defined by the number of people currently living in the same household as the participant, and was grouped into two categories: *living alone or with one other person* in the household or *living with ≥2 other persons* in the household. Participants were classified as *living with children* if one or more of their household members were under the age of 18. Worries about being infected and about adverse health consequences if infected were ascertained by questionnaire in which participants were asked to what extent they were worried about contracting the virus or about the consequences of an infection on their own health and they could answer "not at all," "a little," "moderately," "very," or "extremely." Two categories, for each variable, were defined: those, who were *very to extremely worried* and those, who were *not at all to moderately worried* about an infection or adverse health consequences if infected.

## Statistical analysis

We modeled the association between working from home and SARS-CoV-2 infection through logistic regression analyses. Three sets of models were fitted: model (1) unadjusted, model (2) adjusted for age and gender, and model (3) adjusted for age, gender, education, work site, and vulnerability. Results were reported as odds ratios and 95% confidence interval in tables and visualized on the logarithmic scale in plots. To evaluate effect modification, we modeled the association between working from home and SARS-CoV-2 infection across strata of the potential effect modifier under consideration.

In sensitivity analysis, we performed the same analyses excluding participants who *only sometimes worked from home*, hence only those who reported *never working from home* and those who reported *most of the time working from home* during spring 2020 were considered. Missing data for variables used in the analyses are reported in Table 1. Statistical analyses were performed using the software R (version 4.1.0).

# Results

Overall, 1,310 employees from both Nestlé sites were invited and 425 (33%) participated. Characteristics of participants are reported in Table 1. Some 53% of the participants were women and mean age was 42 years (age range between 21 and 64 years). Some 37% worked most of the time from home during 2020 and 63% never or only sometimes worked from home. Overall, 16% had been infected with SARS-CoV-2 by February 2021.

The associations between SARS-CoV-2 infection and work from home are reported in Table 2. Participants working most of the time from home in 2020 had higher odds of being infected with SARS-CoV-2 compared to participants never or

TABLE 1 Characteristics of study participants overall and of those infected with SARS-CoV-2[a].

| | *N* (%) | Infected with SARS-CoV-2 (%) |
|---|---|---|
| Total | 425 (100) | 66 (16) |
| **Gender** | | |
| Women | 224 (53) | 32 (14) |
| Men | 201 (47) | 34 (17) |
| **Age group, years** | | |
| 18–34 | 103 (24) | 24 (23) |
| 35–49 | 214 (50) | 25 (12) |
| 50–65 | 108 (25) | 17 (16) |
| **Education level**[b] | | |
| Basic education | 116 (27) | 20 (17) |
| Advanced education | 309 (73) | 46 (15) |
| **Household size** | | |
| Living alone or with one other person | 179 (42) | 29 (16) |
| Living with ≥2 other persons | 246 (58) | 37 (15) |
| **Children in household** | | |
| Living without children | 230 (54) | 39 (17) |
| Living with ≥1 child | 195 (46) | 27 (14) |
| **Vulnerability criteria**[c] | | |
| None | 337 (79) | 53 (16) |
| ≥1 | 88 (21) | 13 (15) |
| **PCR test**[d] | | |
| None | 145 (34) | 14 (10) |
| Positive result | 27 (6) | 24 (89) |
| Negative result | 244 (57) | 27 (11) |
| Unknown result | 9 (2) | 1 (11) |
| **Worried about being infected** | | |
| Not at all to moderately | 352 (83) | 54 (15) |
| Very to extremely | 73 (17) | 12 (16) |
| **Worried about adverse health consequences if infected** | | |
| Not at all to moderately | 349 (82) | 51 (15) |
| Very to extremely | 75 (18) | 15 (20) |
| Missing data | 1 (0) | 0 (0) |
| **Nestlé sites** | | |
| Nestlé research center (Lausanne, Vaud) | 299 (70) | 46 (15) |
| Nestlé factory (Romont, Fribourg) | 126 (30) | 20 (16) |
| **Work from home in 2020** | | |
| Never or sometimes | 266 (63) | 39 (15) |
| Most of the time | 159 (37) | 27 (17) |

Results are N (%). All data beside serology, gender and age, are self-reported.

[a] Participants with positive IgG antibodies to SARS-CoV-2 in the blood are considered to have been infected with the virus at least once since the beginning of the pandemic.

[b] Basic education includes mandatory education, apprenticeship or Matura. Advanced education includes technical college, university or polytechnic.

[c] Vulnerability is defined according to the criteria of the Federal Office of Public Health (9).

[d] Participants were asked whether they had taken a PCR test since the beginning of the pandemic before the study blood test, and about the result of the test. Some PCR tests have been taken shortly before the blood test and the results were therefore still unknown when the participants completed the questionnaire.

only sometimes working from home. The confidence intervals were wide, however, and crossed the null value. Performing similar analyses in the sample without the participants who only sometimes worked from home led to similar results (Supplementary Table 1).

The associations between SARS-CoV-2 infection and work from home across strata of household size and living with children are reported in Table 3; Figure 2. Among participants living alone or with one other person in the household, those who worked most of the time from home had higher odds of being infected with SARS-CoV-2 compared to those who never or only sometimes worked from home with wide confidence intervals but not crossing the null value (adjusted OR 2.62, 95% CI 1.13–6.25). Among participants living with two or more other persons in the household, the odds of being infected were lower when working most of the time from home compared to those who never or only sometimes worked from home. Therefore, participants living with fewer household members seemed at higher risk of infection when working from home, while those living with more than two people seemed at lower risk. Furthermore, working from home was associated with more infections among participants living without children, whereas no association was observed among participants living with children, although the confidence intervals were wide and crossed the null value.

The associations between SARS-CoV-2 infection and work from home across strata of vulnerability and worries are reported in Table 3; Figure 3. Vulnerable participants tended to have lower odds of being infected when they worked from home compared to when they never or only sometimes worked from home, while non-vulnerable participants tended to have higher odds. While working from home was associated with more infections whatever the worries of being infected were, working from home was not associated with more infections when stratified by worries about adverse health consequences if infected with the virus. One missing value was reported among the variable concerning worries about adverse health consequences if infected and was not used in the analysis. In all these analyses, confidence intervals were wide and crossed the null value. Supplementary Table 2 summarizes the number of participants being infected or not with SARS-CoV-2 in each subgroup of potential effect modifiers.

## Discussion

In this seroepidemiological study, we investigated whether employees working from home in 2020, compared to those working on site with strict sanitary measures, had different SARS-CoV-2 infection rates by February 2021. The sample population included employees from two Nestlé sites based in Switzerland. Our results suggested overall higher odds of being infected with SARS-CoV-2 when working most of the

TABLE 2 Association between work from home and SARS-CoV-2[a] infection assessed through logistic regression ($n = 425$).

| | **Model 1*** OR (95% CI) | **Model 2**** OR (95% CI) | **Model 3***** OR (95% CI) |
|---|---|---|---|
| **Work from home** | | | |
| Never or sometimes | Ref | Ref | Ref |
| Most of the time | 1.19 (0.69–2.03) | 1.22 (0.70–2.11) | 1.29 (0.73–2.27) |
| **Gender** | | | |
| Women | – | Ref | Ref |
| Men | – | 1.32 (0.77–2.28) | 1.39 (0.78–2.49) |
| **Age group, years** | | | |
| 18–34 | – | Ref | Ref |
| 35–49 | – | 0.43 (0.23–0.79) | 0.43 (0.2–0.79) |
| 50–65 | – | 0.62 (0.31–1.24) | 0.58 (0.27–1.19) |
| **Education**[b] | | | |
| Basic education | – | – | Ref |
| Advanced education | – | – | 0.75 (0.40–1.45) |
| **Work site** | | | |
| Nestlé research center (Lausanne, Vaud) | – | – | Ref |
| Nestlé factory (Romont, Fribourg) | – | – | 0.86 (0.44–1.64) |
| **Vulnerability** | | | |
| None | – | – | Ref |
| ≥1 | – | – | 0.89 (0.44–1.72) |

* Unadjusted.
** Adjusted for age and gender.
*** Adjusted for age, gender, education, work site, vulnerability.
OR = odds ratio, 95% CI = 95% confidence interval.
[a] Participants with positive IgG antibodies to SARS-CoV-2 in the blood are considered to have been infected with the virus at least once since the beginning of the pandemic.
[b] Basic education includes mandatory education, apprenticeship or Matura. Advanced education includes technical college, university or polytechnic.

time from home compared to never or only sometimes working from home. This finding suggests that, in a setting with strict sanitary measures implemented in the workplace, which aimed at limiting SARS-CoV-2 transmission, employees mobilized on site were not at an increased risk of SARS-CoV-2 infection compared to those working from home. We observed a stronger association between working from home and SARS-CoV-2 infection in participants living alone or with one other person, while among participants living with two or more other persons and among those vulnerable, working from home tended to be associated with lower odds of being infected.

To our knowledge, only few studies have investigated the relationship between SARS-CoV-2 infection among employees working from home and on site, and none has investigated effect modification on this relationship. Consistent with our findings, in a study conducted among essential workers recruited in various companies in Geneva, Switzerland, Stringhini et al. found that the risk of infection ascertained by the presence of anti-SARS-CoV-2 IgG antibodies between May and September 2020 was higher in participants who were fully working from home in spring 2020 compared to those who were working from home only partially or not at all (RR 1.27, 95% CI 1.03–1.56) (16). On the contrary, in a case-control study by Galmiche et al., whereby PCR-diagnosed COVID-19 cases retrieved from a national database in France were compared to matched controls with no previously suspected SARS-CoV-2 infection, working from home in the 10 days previous to infection or enrollment was associated with a lower risk of SARS-CoV-2 infection (7). Hence, evidence for the relationship between working from home and SARS-CoV-2 infection is currently scarce and contradictory, and differences in study design and setting complicate comparisons.

Our findings from the effect modification analyses show that working most of the time from home did not result in fewer SARS-CoV-2 infections, especially among those with fewer social contacts in the household. It is possible that people, who lived with fewer household members and worked from home were going out more often, for example to fitness centers or bars, which were settings with less strict sanitary measures than in the workplace and which have been shown to increase the risk of infection (7, 17). They may also be less compliant with protective measures because of their reduced responsibility for other household members. Participants living with children may

TABLE 3 Association between work from home and SARS-CoV-2[a] infection stratified by potential effect modifiers.

| | Unadjusted OR (95% CI) | Adjusted OR* (95% CI) |
|---|---|---|
| **Household size** | | |
| Living alone or with one other person | 2.46 (1.10–5.60) | 2.62 (1.13–6.25) |
| Living with ≥2 other persons | 0.66 (0.29–1.36) | 0.66 (0.30–1.39) |
| **Children in household** | | |
| Living without children | 1.41 (0.69–2.85) | 1.43 (0.68–2.94) |
| Living with ≥1 child | 0.99 (0.42–2.24) | 1.07 (0.45–2.46) |
| **Vulnerability criteria**[b] | | |
| None | 1.39 (0.76–2.51) | 1.44 (0.79–2.63) |
| ≥1 | 0.63 (0.16–2.13) | 0.53 (0.13–1.93) |
| **Worried about being infected** | | |
| Not at all to moderately | 1.15 (0.63–2.06) | 1.13 (0.62–2.05) |
| Very to extremely | 1.53 (0.37–5.64) | 2.08 (0.46–9.07) |
| **Worried about adverse health consequences if infected** | | |
| Not at all to moderately | 0.96 (0.51–1.76) | 0.96 (0.51–1.76) |
| Very to extremely | 0.91 (0.29–2.68) | 0.99 (0.30–3.16) |

* Adjusted for age and gender.
OR = odds ratio, 95% CI = 95% confidence interval.
[a] Participants with positive IgG antibodies to SARS-CoV-2 in the blood are considered to have been infected with the virus at least once since the beginning of the pandemic.
[b] Vulnerability is defined according to the criteria of the Federal Office of Public Health (9).

have less non-household contacts overall because they are more likely to stay at home and spend time with their family (18). Our findings, however, support the hypothesis that working most of the time from home would lead to fewer SARS-CoV-2 infections among vulnerable individuals. Vulnerable individuals were advised to stay at home and to take special care to avoid infection to reduce the risk of developing a severe form of COVID-19 (9). Hence, working from home and limiting social contacts may be an additional opportunity for vulnerable individuals to avoid exposure to SARS-CoV-2 and thus reduce the number of infections.

Our study has several limitations. We may underestimate the proportion of participants who were infected. Indeed, there is evidence that following an infection, some people do not develop antibodies (19). In addition, some participants may have been recently infected and not yet developed antibodies. It is also possible that some people who were infected a few months before the data were collected for this study developed antibodies, but that they declined over time (20). Another limitation is that we cannot identify the time of infection. Hence, it is possible that some participants were infected and developed antibodies before any sanitary measures were implemented. As a result, it is more difficult to show a difference in risk between working from home and on site.

While we included up to 33% of all invited employees, our study may be subject to some selection bias. For instance, employees working from home may have had a lower willingness to participate since study visits required to come to the workplace for the blood test, especially as recruitment started shortly before a reinforcement of the sanitary measures from early January 2021. Also, having had a previous infection might have impacted the willingness to participate, although it is hard to tell in which direction. Hence, the willingness to participate could be a collider on which we conditioned our analyses, therefore introducing bias (21).

Furthermore, our study may be subject to some misclassification bias both in the exposure and the outcome. First, we classified participants into two exposure groups based on both self-reported share of work from home during spring 2020 and the work organization implemented by the company, from which we assumed how the participants worked throughout the year. This may have led to random misclassification in the exposure, resulting in estimates biased toward the null value (22). Second, although a highly sensitive and specific SARS-CoV-2 antibody test was used (11, 15), we did not account for antibody waning over time, which may especially concern individuals who were infected early during the pandemic (20). Nevertheless, we assume that this possible misclassification in the outcome is likely to be non-differential with respect to working from home or not, which should not bias the estimate but could increase the variability around the estimates (22).

Finally, the limited number of participants reduced the statistical power of our analyses, especially for the ones conducted in strata of the sample. Most of the estimates we found had wide confidence intervals crossing the null value, hence it is possible that individuals working from home did not truly have higher odds of being infected. Overall, we did not find a clear signal, which may be due to misclassification in both the exposure and the outcome as well as the low sample size. Ideally, this study should be repeated in a larger sample.

Our study has several strengths. This study is one of the few conducted at a company outside of the healthcare sector with an implementation of work from home when possible and strict sanitary measures implemented on site. The main strength is the use of the presence of antibodies in a population-based sample to ascertain the cumulative number of SARS-CoV-2 infections instead of PCR-based case finding. Indeed, the latter only detects acute infections (23) and is conditioned by the

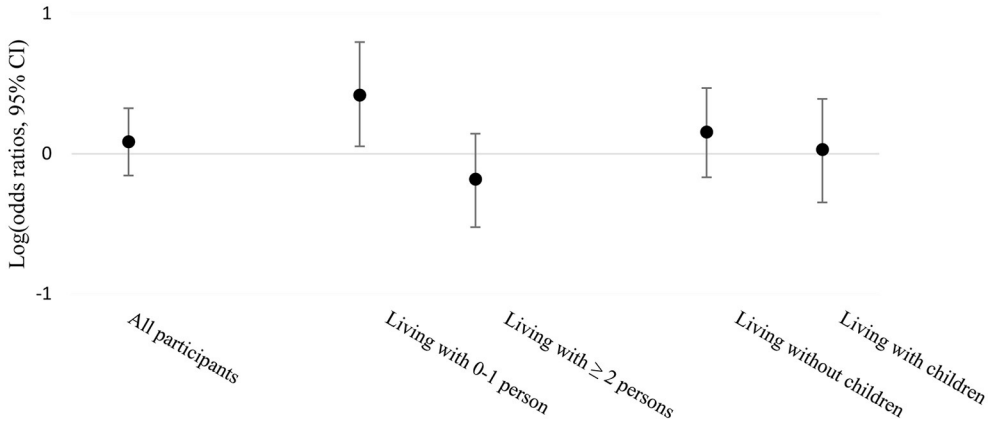


FIGURE 2
Association between work from home and SARS-CoV-2 infection stratified by household size and living with children or not, displayed on the logarithmic scale of odds ratios and 95% CI.

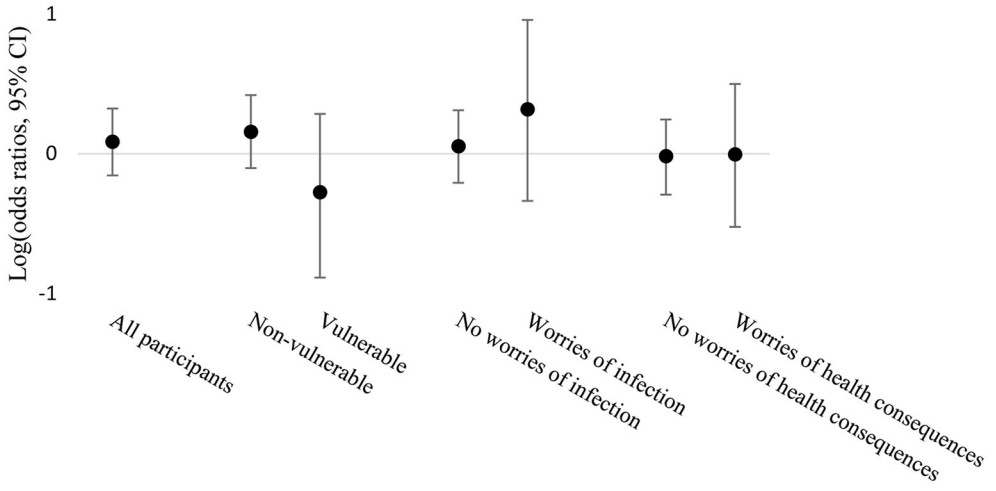


FIGURE 3
Association between work from home and SARS-CoV-2 infection stratified by vulnerability, worries about being infected and worries about adverse health consequences if infected, displayed on the logarithmic scale of odds ratios and 95% CI.

testing strategy in place, whereby for instance asymptomatic cases are mostly underreported (24). On the contrary, antibody testing on a population-based sample also detects asymptomatic infections and detects infections up to 34 months post-infection (25), hence it is a more accurate proxy of the cumulative number of infections that occurred in the population and reduces the risk of misclassification bias.

According to the current study, there is an overall higher number of infections among individuals working from home, however, our study design does not allow us to state that working from home has a causal effect on the risk of being infected. Importantly, our results should be interpreted in the context of a multinational company deciding to implement a specialized occupational safety unit that immediately deployed a wide range of sanitary measures from the beginning of the pandemic. Thus, it is likely that SARS-CoV-2 infections were more frequent outside the workplace (8, 26) and that implementation of a combination of measures, such as reducing work-related close contact, likely played an important role in SARS-CoV-2 transmission (3, 4, 16). Overall, this may explain why the seroprevalence in this sample was similar to that of the general working-age population of the cantons of Vaud (25%) and Fribourg (18%), where antibodies were measured during the same period (27).

Beyond the viral spread, the impact on individuals and the society must also be considered when implementing work

from home (28). Mandatory working from home may have negative consequences on physical and mental health due to stress, anxiety, difficulty managing work-life balance, and social isolation (1, 28–30). However, it also allows for flexible work models, whereby employees can benefit from personalizing their work arrangements (31–33).

In this study, we found that participants employed in a multinational company, who worked most of the time from home during 2020, had higher odds to be infected with SARS-CoV-2 by February 2021 compared to those working on site with strict sanitary measures. In conclusion, our results suggest that, in a context of strict sanitary measures implemented in the workplace, employees working from home did not seem to be at lower risk of infection compared to those working on site, especially if living alone or with one other person.

## 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 Cantonal Research Ethics Commission of Zürich and Vaud, Switzerland (BASEC 2020-01247). The patients/participants provided their written informed consent to participate in this study.

## Author contributions

P-YR, AC, and AS contributed to the design of the Corona Immunitas Nestlé study based on the protocol provided by the National Corona Immunitas team. AS and NP contributed to the data collection. P-YR, AC, DA, and AS contributed to the conception and design of the work. AS and DA drafted the manuscript and contributed to the statistical analysis and interpretation of data. DA was involved in supervision and support with data management. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

Authors IB-F, NP, and SCM were employed by Nestlé Research. The funder was involved in the recruitment and blood sample acquisition, but had no role in the design of the study, data analyses and interpretation of data. The funder provided suggestions on a draft of the manuscript, but the final decision on the content was made solely by the senior author P-YR.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



## Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.980482/full#supplementary-material

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EDITED BY
Susana Viegas,
New University of Lisbon, Portugal

REVIEWED BY
Francesco Chirico,
Catholic University of the Sacred Heart Rome, Italy
Mahdi Malakoutikhah,
Kashan University of Medical Sciences, Iran

*CORRESPONDENCE
Somayeh Tahernejad
tahernezhad.somaye@gmail.com

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# Personal protective equipment-associated headaches in health care workers during COVID-19: A systematic review and meta-analysis

Ali Sahebi[1], Naser Hasheminejad[2], Masoumeh Shohani[3], Atefeh Yousefi[4], Somayeh Tahernejad[5]* and Azadeh Tahernejad[6]

[1]Non-Communicable Diseases Research Center, Ilam University of Medical Sciences, Ilam, Iran, [2]Department of Occupational Health Engineering and Safety at Work, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran, [3]Department of Nursing, School of Nursing and Midwifery, Ilam University of Medical Sciences, Ilam, Iran, [4]Department of Neurology, Shohadaye Tajrish Hospital, Shahid Beheshti University of Medical Science, Tehran, Iran, [5]Health in Disasters and Emergencies Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran, [6]Department of Health in Disasters and Emergencies, School of Public Health and Safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran

**Introduction:** Health Care Workers (HCWs) use Personal Protective Equipment (PPE) during the COVID-19 pandemic to protect themselves and prevent the transmission of the disease. The use of PPE, especially respiratory masks, has adverse consequences, including headaches, which have been secondary and unusual. The aim of the present systematic review and meta-analysis study was to investigate the prevalence of PPE-associated headaches in HCWs during COVID-19 pandemic.

**Methods:** The present review study was performed based on the PRISMA guideline. The protocol of the present study was registered in PROSPERO with the code CRD42022304437. Valid data resources such as Scopus, PubMed, Web of Science, Science Direct, Google Scholar, Embase were used to identify and extract relevant studies. The searches were conducted between the beginning of 2020 and the end of January 2022. A random effects model was used for meta-analysis and $I^2$ index was used to investigate between-study heterogeneity. Data were analyzed using STATA ver. 14.

**Results:** A total of 539 articles were first identified through initial search and finally 26 final studies were selected to undergo the meta-analysis phase. According to the results of meta-analysis, the prevalence of headache after and before the use of PPE was 48.27% (95% CI: 40.20–56.34, $I^2 = 99.3\%$, $p = 0 < 001$) and 30.47% (95% CI: 20.47–40.47, $I^2 = 97.3\%$, $p = 0 < 001$), respectively.

**Conclusion:** The results of the present study showed that the prevalence of PPE-associated headache in HCWs was relatively high, so, the use of

PPE during COVID-19 pandemic can be considered as one of the causes of headache. Therefore, management strategies such as regular screening of HCWs for headaches and regular rest periods without the use of PPE can be effective in reducing the prevalence of headaches.

KEYWORDS

**headache, personal protective equipment, health care workers, respiratory mask, COVID-19**

## Introduction

COVID-19 pandemic has affected the care activities of health care workers (HCWs) (1). Based on the available evidence, the Covid-19 virus is transmitted through close contact between individuals. Those who are in close contact with a Covid-19 patient or care for COVID-19 patients are at higher risk for the disease. HCWs are therefore required to use Personal Protective Equipment (PPE) to prevent the virus transmission while performing their duties to protect themselves (2–4).

According to the World Health Organization (WHO), PPE included guns, non-sterile gloves, goggles and respiratory masks (2). Although each country has its own certification standard for each mask type (3), in fact, the use of PPE by HCWs has unpleasant and annoying effects that will be exacerbated in the long run (4). However, long-term use of PPE is essential due to the prevalence of infectious diseases such as COVID-19 (4, 5).

The use of PPE, especially respiratory masks, can have a number of consequences, including headaches for HCWs. PPE-associated headaches are an unusual secondary headache, that mainly occur among HCWs due to the use of protective masks, Face masks and/or googles and have recently been studied in various studies (6, 7). PPE-associated headaches are considered as a subtype of external compression headaches (8). Although these headaches are often short-lived and without long-term side effects, they can affect occupational health, professional performance of HCWs, and their behavior in the proper use of PPEs (9).

Changes in staff conditions during the COVID-19 pandemic are more likely to cause PPE-associated headaches (6). Extended hours of work shifts (more than 8 h), combined use of PPE for long periods of time, or a higher physical and cognitive workload of HCWs when using PPE can increase the prevalence of PPE-associated headaches (7, 10–12). Studies have shown that using PPE every hour increases the risk of new symptoms (including headaches) by 1.38 times (18). Considering that the COVID-19 pandemic has provided an opportunity to study PPE-associated headaches among HCWs, the prevalence of PPE- associated headaches among HCWs has been assessed and reported in many studies since the onset of the COVID-19 pandemic (6, 13, 14). However, the results showed that there has been no comprehensive study on the prevalence of PPE-associated headaches HCWs during COVID-19 pandemic.

Therefore, this study was conducted with the aim of investigating the prevalence of headache associated with PPE in HCWs during COVID-19, and the prevalence of headache after using PPE and before using PPE was investigated among the studies conducted in this field. The results of this study can show whether HCWs are more prone to headaches after using PPE. Considering the importance of the subject matter, the results of the present systematic review and meta-analysis may provide an important source of information for health planning in addition to adding information about PPE-related headaches.

## Methods

Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) guideline was used to conduct the present systematic review and meta-analysis (15). The protocol of the present review study was registered in International Prospective Register of Systematic Review (PROSPERO) with the code CRD42022304437.

### Data resources and search strategy

In this research, Data resources including PubMed, Scopus, Web of Science, Science Direct, Google Scholar, Embase, were used to search and extract studies. Also, valid keywords such as Headache*, "Head Pain*," Cephalgia*, COVID 19, "SARS-CoV-2 Infection", "SARS CoV 2 Infection,*" "2019 Novel Coronavirus Disease," "2019 Novel Coronavirus Infection," "2019-nCoV Disease,*" "COVID-19 Virus Infection,*" "Coronavirus Disease 2019," "Coronavirus Disease-19," "Coronavirus Disease 19," "Severe Acute Respiratory Syndrome Coronavirus 2 Infection," "SARS Coronavirus 2 Infection," "COVID-19 Virus Disease,*" "2019-nCoV Infection,*" COVID19 OR "COVID-19 Pandemic,*" "COVID 19 Pandemic," "Personal Protective Equipment,*" "PPE Personal Protective Equipment," PPE OR Mask,* "face shield,*" "Air-Purifying Respirator,*" goggle*, "Health Personnel," "Health Care Provider,*" "Healthcare Provider,*" "Healthcare

TABLE 1 Lists the search strategies in various databases.

| Data base | Search strategy |
|---|---|
| Pubmed | (Headache* OR "Head Pain*" OR Cephalgia*) AND (COVID 19 OR "SARS-CoV-2 Infection" OR "SARS CoV 2 Infection*" OR "2019 Novel Coronavirus Disease" OR "2019 Novel Coronavirus Infection" OR "2019-nCoV Disease*" OR "COVID-19 Virus Infection*" OR "Coronavirus Disease 2019" OR "Coronavirus Disease-19" OR "Coronavirus Disease 19" OR "Severe Acute Respiratory Syndrome Coronavirus 2 Infection" OR "SARS Coronavirus 2 Infection" OR "COVID-19 Virus Disease*" OR "2019-nCoV Infection*" OR COVID19 OR "COVID-19 Pandemic*" OR "COVID 19 Pandemic") AND ("Personal Protective Equipment*" OR "PPE Personal Protective Equipment" OR PPE OR Mask* OR "face shield*" OR "Air-Purifying Respirator*" OR goggle*) AND ("Health Personnel" OR "Health Care Provider*" OR "Healthcare Provider*" OR "Healthcare Worker*" OR "Health Care Professional*" OR "healthcare personnel" OR "health care personnel" OR "Medical Staff" OR "Medical worker") |
| Scopus | ((ALL(Headache*) OR ALL("Head Pain*") OR ALL(Cephalgia*)) AND (ALL(COVID 19) OR ALL("SARS-CoV-2 Infection") OR ALL("SARS CoV 2 Infection*") OR ALL("2019 Novel Coronavirus Disease") OR ALL("2019 Novel Coronavirus Infection") OR ALL("2019-nCoV Disease*") OR ALL("COVID-19 Virus Infection*") OR ALL("Coronavirus Disease 2019") OR ALL("Coronavirus Disease-19") OR ALL("Coronavirus Disease 19") OR ALL("Severe Acute Respiratory Syndrome Coronavirus 2 Infection") OR ALL("SARS Coronavirus 2 Infection") OR ALL("COVID-19 Virus Disease*") OR ALL("2019-nCoV Infection*") OR ALL(COVID19) OR ALL("COVID-19 Pandemic*") OR ALL("COVID 19 Pandemic")) AND (ALL("Personal Protective Equipment*") OR ALL("PPE Personal Protective Equipment") OR ALL(PPE) OR ALL(Mask*) OR ALL("face shield*") OR ALL("Air-Purifying Respirator*") OR ALL(goggle*)) AND (ALL("Health Personnel") OR ALL("Health Care Provider*") OR ALL("Healthcare Provider*") OR ALL("Healthcare Worker*") OR ALL("Health Care Professional*") OR ALL("healthcare personnel") OR ALL("health care personnel") OR ALL("Medical Staff") OR ALL("Medical worker"))) |
| Web of Science | ((TS=(Headache*) OR TS= ("Head Pain*") OR TS= (Cephalgia*)) AND (TS= (COVID 19) OR TS= ("SARS-CoV-2 Infection") OR TS= ("SARS CoV 2 Infection*") OR TS= ("2019 Novel Coronavirus Disease") OR TS= ("2019 Novel Coronavirus Infection") OR TS= ("2019-nCoV Disease*") OR TS= ("COVID-19 Virus Infection*") OR TS= ("Coronavirus Disease 2019") OR TS= ("Coronavirus Disease-19") OR TS= ("Coronavirus Disease 19") OR TS= ("Severe Acute Respiratory Syndrome Coronavirus 2 Infection") OR TS= ("SARS Coronavirus 2 Infection") OR TS= ("COVID-19 Virus Disease*") OR TS= ("2019-nCoV Infection*") OR TS= (COVID19) OR TS= ("COVID-19 Pandemic*") OR TS= ("COVID 19 Pandemic")) AND (TS= ("Personal Protective Equipment*") OR TS= ("PPE Personal Protective Equipment") OR TS= (PPE) OR TS=(Mask*) OR TS=("face shield*") OR TS=("Air-Purifying Respirator*") OR TS=(goggle*)) AND (TS= ("Health Personnel") OR TS= ("Health Care Provider*") OR TS= ("Healthcare Provider*") OR TS= ("Healthcare Worker*") OR TS= ("Health Care Professional*") OR TS= ("healthcare personnel") OR TS= ("health care personnel") OR TS= ("Medical Staff") OR TS= ("Medical worker"))) |

Worker,*" "Health Care Professional,*" "healthcare personnel," "health care personnel," "Medical Staff," "Medical worker," Search fields and operators were used to formulate the search strategy. The searches were conducted in English from the beginning of 2020 to the end of January 2022. The search strategy for types of databases is listed in Table 1.

## Inclusion criteria

The inclusion criteria included English articles that investigated PPE-associated headaches in HCWs during COVID-19 pandemic.

## Exclusion criteria

Case report studies, review studies, intervention studies, letter-to-the editor and headache report in non-HCWs as well as report of PPE-associated headache in HCWs in non-COVID 19 situation and also during other pandemics.

## Selection of studies

Endnote 7 software was used to collect the primary identified studies. After removing the duplicates, the titles and abstracts of the remaining studies were screened. In the studies selection phase, two researchers independently read the full text of potentially relevant studies and finally selected studies for qualitative assessment. Any disagreement between reviewers was resolved by a third reviewer.

## Qualitative assessment and data extraction

After selecting the studies, two researchers independently used the Tool Appraisal tool for Cross-Sectional Studies (AXIS) (16) to assess the quality of the selected studies. The possible score range is 0 to 20 and studies with a score above 12 entered the meta-analysis phase. Any disagreement between the reviewers was resolved by the third reviewer. Also, in the data extraction stage, two researchers independently extracted the type of PPE used as well as the prevalence of subsequent

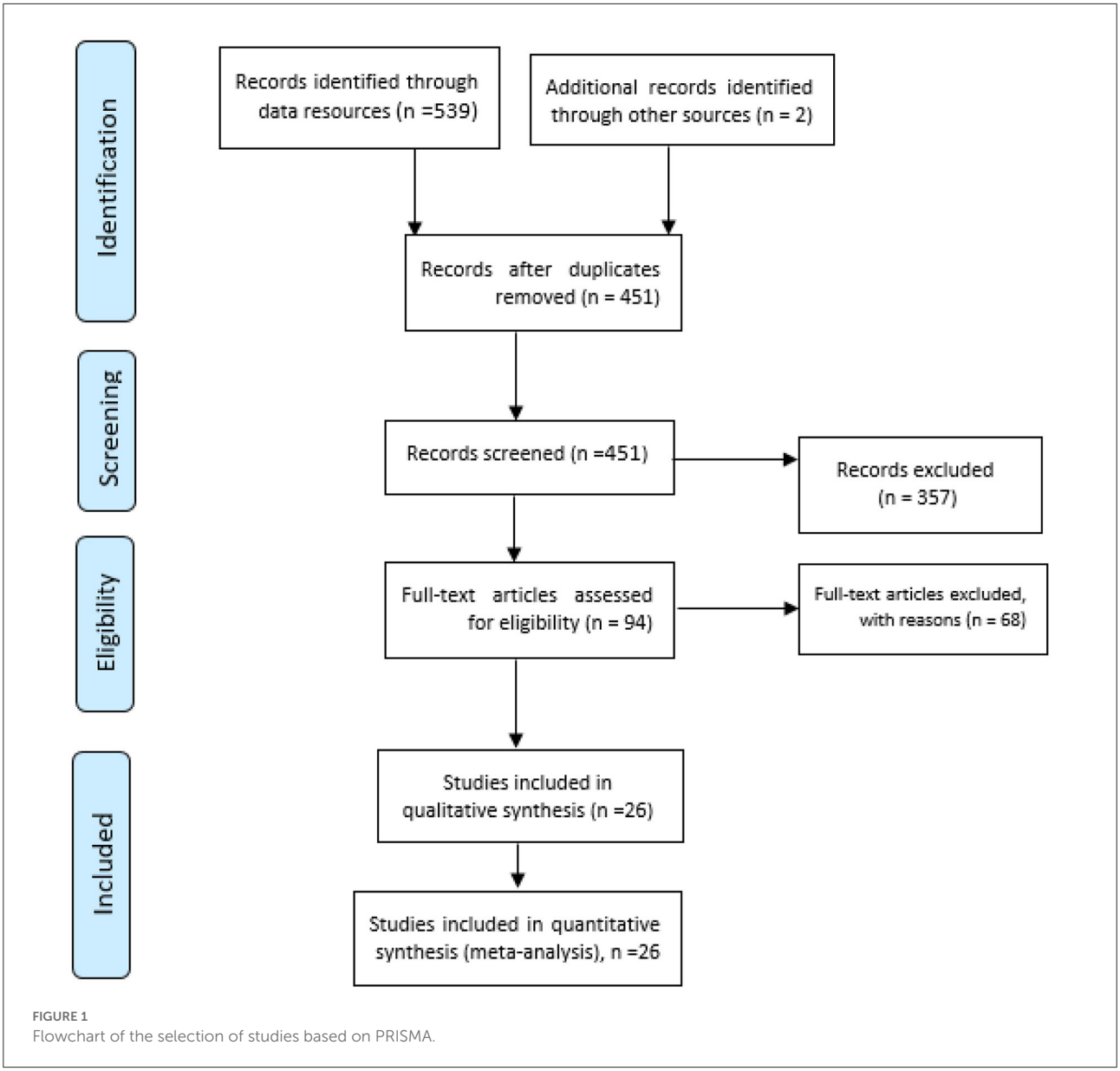


FIGURE 1
Flowchart of the selection of studies based on PRISMA.

headache before and after the use of PPE and using a pre-prepared checklist that includes information on first author, place of study, average age, number of men and women, sample size, duration of PPE use. A third person was used to resolve any disagreement between the two researchers.

## Statistical analysis

I2 index was used to evaluate the between-study heterogeneity. $I^2$ index <25%, 25–50%, 50–75% and more than 75% showed no heterogeneity, moderate, high and very high heterogeneity, respectively (17). In order to reduce the between-study heterogeneity, a random effects model was used for meta-analysis. Begg test was used to evaluate the publication bias. Data analysis was carried out using STATA software ver. 14.

# Results

In this review, 539 initial articles were identified by searching the aforementioned databases. After eliminating duplicates, 451 studies were screened. Afterwards, 94 studies were selected, and finally, 26 studies were selected to undergo quality assessment and then all of them entered the meta-analysis phase (Figure 1). Also, 14,172 HCWs were examined for headaches, of whom 7,986 were male and 6,186 were female. All studies were cross-sectional studies (Table 2). Among the selected studies, face

TABLE 2 The characteristics of studies included in the meta-analysis.

| First author | Location | Sample size | Male | Female | Mean Age (SD) | Pre-existing headaches | Post use PPE headache | Type of PPE | Duration of PPE use |
|---|---|---|---|---|---|---|---|---|---|
| Hajjij et al. (10) | United Arab Emirates | 155 | 48 | 107 | 32 (9.32) | 29% | 32.9% | - N95 Mask<br>- Surgical Mask<br>-Eyes Protective equipment | <4 h (32.9%) >4 h (67.1%) |
| Ong et al. (6) | Singapore | 158 | 47 | 111 | - | 29.1% | 81% | - N95 Mask<br>- Goggles<br>-Face shield/visor | <4 h (16.46%) >4 h (83.54%) |
| Zaheer et al. (18) | Pakistan | 241<br>51 (21.1) | 128 | 113 | 28.5 (6.2) | 21.1% | 28.2% | - N95 Mask<br>- Eyes Protective equipment | <4 h (10%)<br>>4 h (90%) |
| Ramirez-Moreno et al. (19) | Spain | 306 | 62 | 244 | 43 | 41.1% | 51.6% | - surgical Mask<br>- N95 Mask<br>- Face shield<br>- Protective eyewear | Mean (SD) = 6.9 (2.3) h |
| Rapisarda et al. (20) | Italy | 383 | 134 | 249 | 33.4 (9.2) | 56.65 | 26.5% | - Surgical Mask<br>- Other mask | <4 h (6.3%)<br>>4 h (93.7%) |
| Toksoy et al. (21) | Turkey | 375 | 161 | 214 | - | 30.4% | 30.9% | - Filtering Mask<br>- Surgical Mask<br>- Filtering + surgical Mask | <4 h (7.7%)<br>>4 h (92.3%) |
| Jafari et al. (22) | Iran | 243 | 61 | 182 | 36 (8) | 44.3% | 77% | -N95 Mask<br>-surgical Mask<br>-N99 Mask<br>-Goggle<br>-Face shield | >4 h |
| Joy et al. (23) | Bangladesh | 200 | 129 | 71 | 35.4 (7.5) | 11.1% | 59.9% | - N95/FFP3/FFP2 Mask<br>- surgical Mask<br>- N99 Mask<br>- Half/Full Respirator<br>- Goggle<br>-Face shield | <6 h (19.5%)<br>>6 h (80.5%) |

*(Continued)*





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TABLE 2 (Continued)

| First author | Location | Sample size | Male | Female | Mean Age (SD) | Pre-existing headaches | Post use PPE headache | Type of PPE | Duration of PPE use |
|---|---|---|---|---|---|---|---|---|---|
| Çaglar et al. (13) | Turkey | 315 | 156 | 159 | 31.5 (4.6) | - | 36.5% | - N95/FFP2 Mask | >4 h |
| Jose et al. (24) | India | 137 | 64 | 73 | 30.4 (3.3) | - | 73.4% | N95 Mask | 6 h |
| Thiagarajan et al. (25) | India | 342 | 275 | 67 | - | 11.4% | 43% | -N95 Mask<br>- Face shield | <3 h (31%)<br>>3 h (62.3%) |
| Hacibeyoglu et al. (14) | Turkey | 177 | 103 | 74 | 32.3 (7.3) | 31.1% | 65.5% | - N95/FFP2 Mask<br>- Surgical Mask | <4 h (6.2%)<br>>4 h (93.8%) |
| Tabah et al. (26) | Australia | 2,711 | 1,457 | 1,254 | 41 | - | 28% | -N95/FFP2/FFP3 Mask<br>- Surgical Mask<br>PAPR | Median = 4 h |
| Bansal et al. (27) | India | 309 | 146 | 163 | - | - | 44% | -N95 Mask<br>-Surgical Mask<br>-Protective goggle | <4 h (12.9%)<br>>4 h (87.1%) |
| Davey et al. (28) | UK | 224 | 32 | 192 | - | - | 79% | -N95/N99/FFP2/ FFP3 Mask<br>- Surgical Mask | <4 h (26.8%)<br>>4 h (73.2%) |
| Çiriş Yildiz et al. (29) | Turkey | 553 | 166 | 387 | - | - | 74.1% | -N95/FFP2 Mask<br>-Surgical Mask<br>-protective glasses | - |
| Radhakrishnan et al. (30) | India | 2,451 | 1,737 | 714 | - | - | 0.096% | Surgical Mask | - |
| Shubhanshu et al. (31) | India | 423 | 320 | 103 | - | - | 23% | -N95 Mask<br>- Surgical Mask | >4 h |
| Bharatendu et al. (32) | Singapore | 154 | 51 | 103 | 29 (12) | - | 79.9% | N95 Mask | - |
| Rosner et al. (33) | USA | 343 | 28 | 315 | - | - | 71.4% | -N95 Mask<br>- Surgical Mask | >4 h |
| Bai et al. (34) | Pakistan | 126 | 104 | 22 | 40.9 (7.31) | - | 69.2% | face Mask | <6 h (25.4%)<br>>6 h (74.6%) |

*(Continued)*





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TABLE 2 (Continued)

| First author | Location | Sample size | Male | Female | Mean Age (SD) | Pre-existing headaches | Post use PPE headache | Type of PPE | Duration of PPE use |
|---|---|---|---|---|---|---|---|---|---|
| Agarwal et al. (35) | India | 253 | - | - | 42.1 (11) | - | 28% | -N95 Mask<br>- Surgical Mask | <4 h (28%)<br>>4 h (72%) |
| Arif et al. (36) | Pakistan | 196 | 96 | 100 | - | - | 62.5% | -N95 Mask<br>- Surgical Mask | - |
| Peres et al. (37) | Portugal | 3,052 | 500 | 2,550 | - | - | 37.5%<br>19.4% | N95 Mask | <4 h (1.6%)<br>>4 h (98.4%) |
| Cigiloglu et al. (38) | Turkey | 311 | 166 | 145 | 33.4 (7.0) | - | 47.6% | Surgical Mask<br>FFR Mask | Mean (SD) = 9.0 (2.0) |
| Ipek et al. (39) | Turkey | 34 | 15 | 19 | 31.3 (6.3) | - | 59%<br>15% | N95 Mask<br>Surgical Mask | <4 h 100% |

shields were used in 5 studies and protective glasses were used along with masks in 4 studies. In most of the studied studies, surgical masks were used, and in some studies, N95 masks were also used along with surgical masks (Table 2). It should be noted that in the selected studies, most of the study participants used PPE more than 4 h a day. More detailed information about the time of use of the participants in the reviewed studies is presented in Table 2.

According to the results of meta-analysis, the prevalence of headache after and before the use of PPE was 48.27% (95% CI: 40.20–56.34, $I^2 = 99.3\%$, $p = 0 < 001$) (Figure 2) and 30.47% (95% CI: 20.47–40.47, $I^2 = 97.3\%$, $p = 0 < 001$), respectively (Figure 3). The $I^2$ index showed that the between-study heterogeneity is very high. Results of Begg test showed that publication bias in headache after ($P = 0.133$) and before the use of PPE ($P = 0.531$) was negligible (Figures 4, 5).

## Discussion

In the present review study, which was performed to investigate the prevalence of PPE-associated headaches in HCWs during the COVID-19 pandemic, 26 studies were selected for meta-analysis. According to the results of the present meta-analysis, the prevalence of headache after and before the use of PPE use was 48.27% and 30.47%, respectively, indicating that HCWs are more prone to PPE after using it.

In a study on psychological consequences and physical symptoms of HCWs during COVID-19, Chew et al. (40) showed that the prevalence of headache among HCWs was 31.9% and that there is a significant relationship between psychological disorders and physical symptoms (40). In a study on depression among neurosurgeons during COVID-19 pandemic, Sharif et al. (41) reported a headache rate of 20% (41). Yifan et al. (42) reported a headache rate of 19.3% when examining nurses' physical disorders during the Covid-19 pandemic (42). Since the results of the previous studies are consistent with the present study and emphasize the prevalence of headaches without the use of PPE in HCWs, so, it is suggested that health managers should assess these people for headaches due to several factors, including physical and psychological factors. On the other hand, in this study, the prevalence of headache associated with the PPE use was higher than studies in the study of headache without the PPE use, which shows the significant effect of the PPE use on headache among HCWs during the COVID-19 pandemic.

In study on HCWs who used the N95 mask during the SARS epidemic, Lim et al. (43) reported that the prevalence of face mask-associated headaches was 37.3% (43), which is lower than in the present study. Given that the COVID-19 disease is a pandemic and has affected HCWs for a long time, this difference in the prevalence of headache among HCWs can be justified.

A review study investigated the physiological and adverse effects of PPE use and results showed that headache was

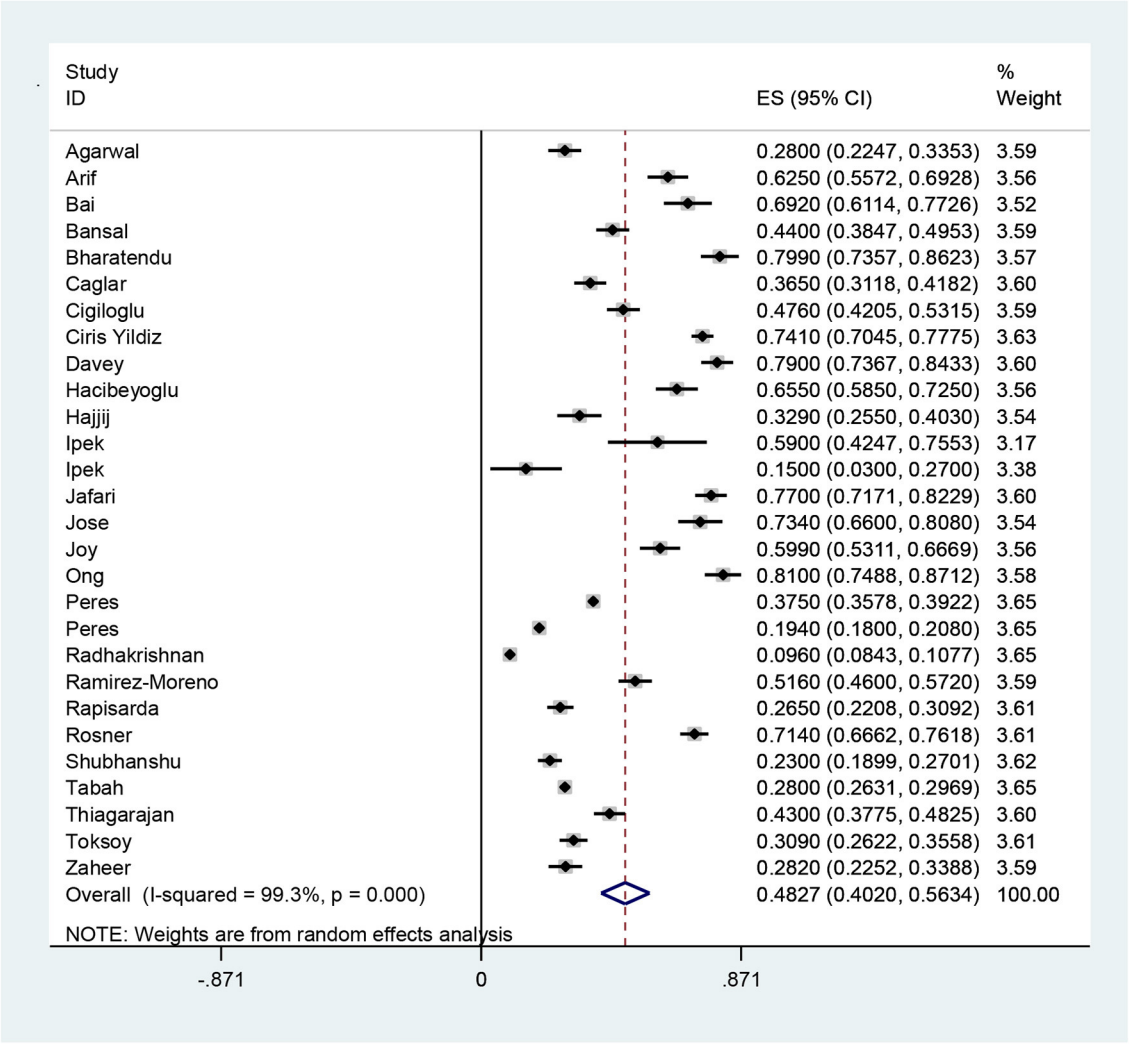


FIGURE 2
The prevalence of headache after the use of PPE and 95% confidence interval for each of the reviewed studies and the total studies. The midpoint of each segment shows the headache estimate and the length of the segment shows a 95% confidence interval. The diamond symbol indicates the total headache.

significant among other side effects (44). In a report sent as a letter-to-the editor, Swaminathan et al., reported that the prevalence of PPE-associated headache was 61.7% (45). The results of these studies are also consistent with the present study.

The face mask and eyewear can exert mechanical forces and stimulate superficial sensory neurons in the skull and neck (46, 47). Scarano et al. showed that long-term use of the FFP2 mask reduced hemoglobin oxygen saturation, increased heart rate, and facial temperature, which may lead to stress and headaches among HCWs (48). High blood carbon dioxide levels can also contribute to side effects such as dizziness, shortness of breath and headache (47). In these studies, factors have been identified as possible risk factors for headaches that are likely to occur to HCWs with the use of PPEs during the COVID-19 pandemic. Therefore, the results of the present study were not unexpected.

Various studies have concluded that headache is associated with prolonged PPE use (13, 24). Spontaneous headache relief has been reported within 60 min after PPE removal (6). Considering that duration of PPE use has increased during the Covid-19 outbreak, it is obvious that, as the results of the present study showed, the prevalence of headache will also increase during this period.

The effect of headache on personal health (both physical and mental health) and work performance has been confirmed in various studies (49–51). Although various factors, such as increased psychological and physical overload and occupational psychosocial stressors (52), may have caused headaches among

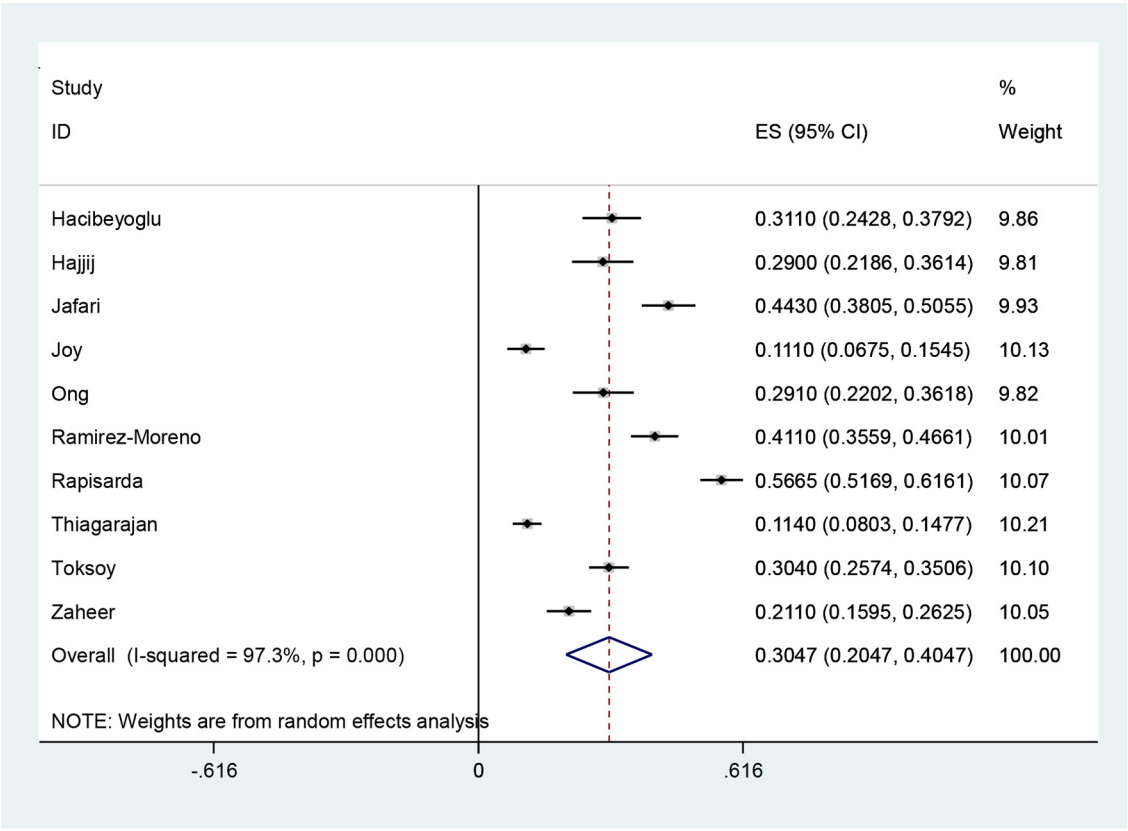


FIGURE 3
Headache rate before the use of PPE and 95% confidence interval for each of the reviewed studies and the total studies. The midpoint of each segment shows the headache estimate and the length of the segment shows a 95% confidence interval. The diamond symbol indicates the total headache.

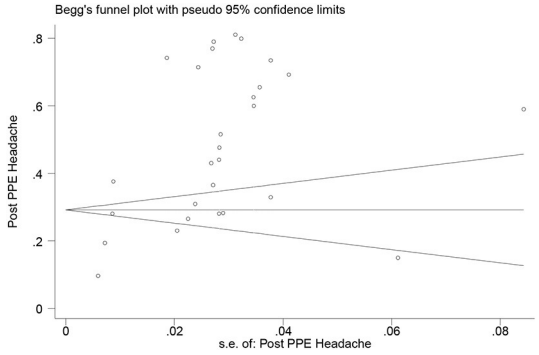


FIGURE 4
Bias publication based on Begg's test regarding headache after the use of PPE.

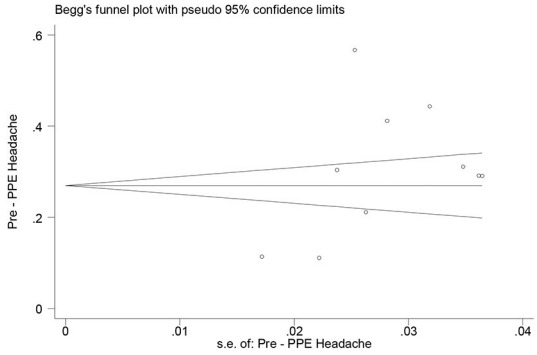


FIGURE 5
Bias publication based on Begg's test for headache before the use of PPE.

HCWs during the outbreak of COVID-19 (40, 41), the PPE use has been cited in various studies as a major cause of headache. In their review study, Ong et al. discussed the clinical features and possible causes of PPE-associated headaches during the COVID-19 pandemic (7). In a narrative review, Romero et al. investigated the causes of headaches among HCWs during COVID-19 and

stated that the physical and homeostatic effects of PPE use may also affect headache (47).

Proper PPE use is crucial for protecting HCWs from COVID-19 and airborne-transmitted infections (53). Therefore, since the results of the present study indicate a significant prevalence of PPE-associated headaches, it is worthwhile for planning committees to take steps to minimize the negative effects of PPE on their personnel and to increase their efforts to address this issue.

However, it is remarkable that PPE-associated headaches are also associated with psychological stress, depression, and sleep disorders, which increased during COVID-19 outbreak among HCWs, as headache is also the most common COVID-19-related neurological symptom (43). Because the aggravation of headaches can have a great impact on the wellbeing and occupational performance of HCWs.

### Limitations

In this study, there was a high heterogeneity between studies, because in different studies that were conducted in this field, the sample size and tools used to assess the prevalence of PPE-Associated headaches were different.

We also failed to assess the prevalence of PPE- associated headaches by gender, Because most studies in this field have not done so. In addition, the timing of PPE use is likely to affect the prevalence of headache, but due to the fact that PPE timing varied in studies, we were unable to investigate this association.

## Conclusion

The present study shows that a significant increase in the prevalence of headache among HCWs during the COVID-19 pandemic. In addition, the PPE use could be one of the causes of headache among HCWs during the COVID-19 pandemic, because the prevalence of headache after the use of PPE was higher than the prevalence of headache before the use of PPE in the present study. Therefore, further studies are needed to investigate the effects of PPE use on the onset of different categories of headache and other neurological conditions. Also, considering the effect of headache on HCWs performance (especially cognitive performance), which can lead to medical errors, in order to achieve a better PPE-user fit, further studies should be performed to provide intervention strategies in order to improve ergonomic features of PPEs that are used for a long time. In addition, management strategies such as regular screenings of HCWs for headaches and devoting rest periods so that HCWs can avoid using PPE for a period of time may also be effective in reducing the incidence of headaches. Therefore, it is recommended to conduct further studies in this field and investigate different solutions.

## Author contributions

AS and ST managed the project. AS, ST, NH, and MS developed the inclusion criteria, screened titles, and abstracts. AY, AS, AT, and ST read and screened articles for inclusion. NH, AY, MS, and ST performed the qualitative assessment and data extraction. AS as a statistician and re-checked statistical analysis. ST, MS, and AT was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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EDITED BY
Grace Sembajwe,
Northwell Health, United States

REVIEWED BY
Muhammad Zulqarnain Arshad,
Universiti Utara Malaysia, Malaysia
Kun-Shan Wu,
Tamkang University, Taiwan

*CORRESPONDENCE
Ahmad Adeel
adeelleads@yahoo.com

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# Conflict side of creativity: Role of supervisory support and team affective tone in facilitating creative idea validation

Ahmad Adeel[1,2]*, Daisy Mui Hung Kee[2] and Yahya Qasim Daghriri[2]

[1]Department of Business Education, The University of Chenab, Lahore, Pakistan, [2]School of Management, Universiti Sians Malaysia, Penang, Malaysia

**Purpose:** We seek to understand whether relationship conflicts of co-workers affect the validation of creative ideas or not. Furthermore, what boundary conditions may help prevent potential drawbacks of relationship conflicts with co-workers to validate their creative ideas?

**Design/methodology/approach:** The proposed model was tested by using multisource data collected across two points in time from final year nursing students and medical dispensers of five nursing colleges of south-Punjab, Pakistan. The model was analyzed with Mplus for random coefficient models for direct effects, mediated moderation, and UCINET for central tendency of creative idea validation.

**Findings:** It was found that relationship conflicts with co-workers were negatively related to their validation of creative ideas. However, supervisory support and team affective tone independently attenuate the negative effects of relationship conflicts with co-workers and the validation of creative ideas. Positive affective tone emerged as a positive predictor of creative idea validation. Additionally, positive affective tone as affected by supervisory support attenuated the negative relationship between relationship conflicts with co-workers and their validation of creative ideas. Finally, the relationship between relationship conflicts with co-workers and their validation of creative ideas is more positive when both supervisory support and positive affective tone are high, however, low otherwise.

**Practical implications:** This study will help policymakers understand what might be hindering the transfer of creative ideas to influential others (Leaders, Managers, etc.) and what they need to do to enhance the creative pool of their organizations. Although developing an environment that fosters creativity is important for the organizations, developing strategies to manage relationship conflicts related to supervisory support and positive affective tone will help transfer creative ideas to higher offices even when there are dysfunctional conflicts.

**Originality/value:** This research shifts the conventional focus of understanding creativity from the generating side by explaining challenges that creative individuals face in promoting creative ideas with more criticism and offense by coworkers than support. Also, the interplay between the relationship conflicts with co-workers and team affective tone affected by supervisory support for validation of creative ideas enhanced our understanding of the boundary conditions of relationship conflict and creative idea validation.

KEYWORDS

**relationship conflicts, creative idea validation, supervisory support, team affective tone, belongingness, creativity, innovation**

## Introduction

Innovation: the implementation of creative ideas, includes several stages, creativity: the generation of novel and useful ideas is the obvious point of departure for innovation to take place (1–4). However, another important stage in this process is ideas validation where the idea generator approach co-workers for refining their ideas, in social interactions (3, 5), before any formal approval of the competent authorities (5–7). Validated ideas adds to the idea pool of the organization (8), however, ideas which fail to find any validation or endorsement just increase sunk cost for the organizations as they fail to contribute to their organization (2, 9). Given that idea validation is critical for the organizations (3, 10), identifying its antecedents has become a pressing issue in contemporary research (1, 3, 11, 12).

Relationship conflicts refer to the tension stemming from interpersonal incompatibilities in personalities and emotions (13) are part of organizational life (14). These conflicts, are detrimental to creative process (3, 6, 10, 15, 16). Thereby, researchers have highlighted the importance of studying relationship conflicts so as to ensure that employees work properly (17) and organizations can capitalize on the creative potential of their employees (3, 18, 19). Whereas, idea validation is predominantly inflected by social interactions and influence (1, 3); Social conflicts on the part of employees is detrimental to organizations because it may inhibit the organization to capitalize on employees' creativity (20, 21). Thereby, investigating creative idea validation in the presence of relationships conflicts is significant for the research. More specifically, it is critical to understand both when co-workers validate ideas of those with whom they maintain relationship conflicts and how the negative effects of relationship conflicts can be reduced for validation of creative ideas. Our research further contributes to filling this gap.

We build on the belongingness theory (22) that explains the fundamental role of interpersonal relationships and the distal consequences (22, 23). The overarching tenant of the theory is that positive relationships are translated into supportive behaviors; however, dysfunctional relationships avoid interactions with the conflicts' targets. Thus, the belongingness theory is distinctively placed in both resolving and explaining this complication in the creative process. By following the contingency perspective (19, 24), based on previous findings that supervisory support may moderate the extent to which conflicts may have beneficial consequences (25, 26). Also, according to the contingency perspective on the conflict-outcome relationship, team affective tone as collectively interactive activities (24, 27) may serve as boundary conditions to explain the extent to which interpersonal conflicts may bring beneficial outcomes. Thus, we propose that when supported by supervisors for a positive team affective tone, a conflict-provoking person will get validation of his creative ideas, thereby buffering the negative influence of relationship conflicts on creative idea validation.

The current study contributes to the literature in several ways. First, employee creativity research has predominantly focused on the idea generation part of creativity, ignoring the challenges creative individuals face in promoting creative ideas with more criticism and offense by coworkers than support (1, 28, 29). Additionally, communication between coworkers plays a significant role in the creative process (15, 19, 30). Less is known about the role and impact of communication hazards for creative idea validation. Second, using contingency perspective, we identify interplays between the relationship conflicts with co-workers and team affective tone as affected by supervisory support for validation of creative ideas that may clarify that under what conditions detrimental effects of conflicts can have repercussions for focal employees' creativity. The study addresses the importance of a supportive environment, including supervisory support and affective team tone in creating buffer between negative consequences of relationship conflicts between co-workers.

Third, communication between coworkers plays a significant role in their creative idea validation of their colleagues. In this study, we have not only examined the effects of conflict on creative idea validation but also identified the

importance of the dual process of communication (including verbal and non-verbal cues) in creating buffering effects in explaining the reduction of harmful effects of relationship conflict on creative idea validation by co-workers. Finally, in the creative process, the empirical research predominantly focused on variance-focused creativity (problem identification, information searching, idea generation); little is known about selection-focused creativity (idea validation, idea endorsement) (3, 31). Overall, due to the practical value of how people receive creativity, the need to understand the receiving side of creativity has been raised (32, 33). Thus, with this research, we have made some distinct contributions to creativity and conflict research.

# Literature review and hypothesis development

## Relationship conflicts and creative idea validation

The belongingness theory (22) establishes and explains the fundamental role of interpersonal relationships in explaining human lives and behaviors. According to this theory, predominantly individuals have a strong need to belong; thus, they seek interpersonal contacts and cultivate desired relationships. In an ideal situation, these interpersonal contacts are free from conflicts and negative effects, positive in nature, and produce affectively pleasant behaviors. However, based on the nature of interpersonal relationships, interpersonal relationships have their distal and proximal consequences. Broadly, as explained by the theory (22), when individuals have dysfunctional relationships with others, they may experience being avoided by others and may fail to obtain required feedback and resources (22). Thus, in our research, belongingness theory is distinctively placed for explaining the role of relationship conflicts of creative individuals and validation of creative ideas by peers at work.

Co-workers' relationship and its impact on co-worker creative idea validation are important issues that need attention in the literature. Although creative idea generation is a solitary activity (32, 34), however, relationship contexts in a workgroup impact an individual's actions. Employees' relationship with their co-workers may impact the degree to which they are motivated to get engaged with creative undertakings (35–39). In a workgroup environment, employees interact with their co-workers the way they interact with their supervisors. These interactions include both work and non-work activities/tasks, which can impact their behavior generally and their creative performance particularly as it is the consequence of these behaviors (34, 36, 37, 40). Literature has identified that not only group characteristics including size, gender profile work, the experience of members, etc. but, group dynamics in the form of cohesion, interaction and communication process between its members also have a profound influence on its member's creative performance (37, 41, 42).

Previous research on co-worker relationships (43, 44) acknowledges that communication about ideas occurs during all stages of the creative process. During earlier stages of the creative process, individuals share their knowledge with their co-workers and receive input from them. This input can be related to relevant task knowledge or complete change in perspectives (45). These co-workers' interactions might revamp ideas and be considered a foundation for idea incubation (5). So, when there are relationship conflicts between co-workers, there will be limited communication between them (22, 46). This lack of relationship or relationship conflict between co-workers would negatively affect creative idea validation. Based on the above discussion following hypothesis is placed

**H1: Relationship conflicts with co-workers are negatively related to their validation of creative ideas.**

## Moderating impact of supervisory support

Supervisory support is linked to a higher level of subordinate creativity (47, 48). Literature also supports the link between the values of supervisors and organization innovation rates (49). We have to test whether the supervisory behavior/support has a moderating impact on the antagonistic relationship between co-workers and their creative idea validation. Supervisors influence subordinates through various forms, including role modeling, goal definition, reward allocation, resource distribution, communication of organizational norms and values, structuring of workgroup interactions, conditioning subordinates' perceptions of the work environment, and influence over processes and procedures used (50–52), ultimately influences employee creativity (53, 54). Similarly, employees' perceptions regarding autonomy, support, trust, and goal clarity contribute to creative idea generation (55, 56) and innovation (57).

Supervisory support also has a psychological influence on employees (58–60) that influence their feelings to develop positive feelings in subordinates through self-efficacy. Employees' feelings influence their work (61), and supervisory support help to create positive feelings in subordinates through self-efficacy. These psychological states result in two outcomes, first, the effectiveness and second, the innovative behavior of subordinates (60, 62). Thus, we propose that supervisory support acts as a buffer in the negative relationship of relationship conflict and coworkers' creative idea validation. The psychological empowerment in subordinates due to supervisory support not only induces creativity but also helps in making the employees feel that they are secure as they have support from their supervisors. Similarly, when co-workers

are clear that one particular employee has support from the supervisor, they are less likely to reject the creative idea of that employee regardless of whether they have relationship conflict with that employee. Hence, based on above discussion following hypothesis is proposed

**H2a: Supervisory support attenuates the negative effects of relationship conflicts with co-workers on their validation of creative ideas, such that relationship conflict's negative impact on co-workers' creative idea validation is even less when supervisory support is high.**

## Moderating impact of team affective tone

Team affective tone is defined as "consistent or homogeneous affective reactions within a group" (63). These affective reactions are shared perceptions of moods and emotional states of team members (64) and can be considered the aggregate moods of team members (65). The shared emotions at the team level can be demonstrated as "team affect." The prior literature has been proposed that team dynamics, effectiveness, and creativity is influenced by team affective tone (66–68). The positive affective moods and behaviors are linked with performance, creativity, and coordination of team members (65, 68, 69). The emotional contagion process through which the state of one team member is transferred to another team member is one of the significant causes of team affective tone (65, 70).

The team members' creative processes and information processing are the two theoretical mechanisms behind the link between the team's affective tone and the creativity of its members (68). The working environment in which the team members operate has an impact on the willingness of the team members to work together and engage in creative work solutions (71, 72). When there are enjoyable interactions with team members, they are more likely to share and discuss their ideas and develop better and creative answers (68, 73). A positive team affective tone works by facilitating team members' creative processes. These positive work interactions help enhance information processing by allowing team members to access additional information through ideas exchanges during group discussions (74). A positive team affective tone develops a working environment where employees set aside their relationship conflicts and achieve collective goals. Team affective tone reduces the harmful effects of relationship conflicts on the coworker's creative idea validation and acts as a buffer. Based on the above discussion following hypothesis is proposed

**H2b: Team affective tone attenuates the negative effects of relationship conflicts with co-workers on their validation of creative ideas, such that, relationship conflict's negative impact on co-workers' creative idea validation is even less when team identification and co-operation are high.**

Our preceding hypothesis proposes that supervisory support produces a positive team affective tone; a positive team affective tone acts as a buffer in transmitting the negative impact of relationship conflict on coworker's creative idea validation. It is predicted that a positive team affective tone mediates the moderating effect of supervisory support on the relationship between relationship conflict and coworkers' creative idea validation (Hypothesis 1), constituting a case of mediated moderation (75). Although mediated moderation can take multiple forms, the type of mediated moderation that we expect is present when (1) a variable (supervisory support) moderates the relationship between an independent variable (relationship conflict between coworkers) and a dependent variable (coworker creative idea validation), as in Hypothesis 1; (2) the moderating variable (supervisory support) causes a mediating variable (positive team affective tone ); and (3) the mediating variable (positive team affective tone) moderates the relationship between an independent variable (relationship conflict between coworkers) and a dependent variable (coworker creative idea validation), thereby transmitting—and eliminating—the moderating effect of the original moderator (supervisory support). Having already proposed these relationships, we present a hypothesis for mediated moderation: supervisory support attenuates the negative effects of relationship conflicts with co-workers on their validation of creative ideas through a positive team affective tone.

**H2c: Team affective tone mediates the moderating effect of supervisory support on the relationship between relationship conflicts with co-workers and creative idea validation**.

"Verbal and non-verbal behavior produced with the intention of providing assistance to others perceived as needing that aid" (76). A growing body of literature has sought to understand the connection between social support and positive outcomes in individuals by looking at the dual process of supportive communication. The Dual-process of communication identifies the importance of both verbal and non-verbal communication, i.e., content and perception about the message. We are proposing here that the dual process of communication plays its role when there is relationship conflict, and coworkers do not validate the creative ideas of their colleagues. In this dual-process of communication, the verbal cues coming from the supervisory support, and non-verbal cues come from the team affective tone. We propose here that both the verbal and non-verbal cues act as a buffer and moderate the negative effects of relationship conflict on creative idea validation by coworkers. Supervisory support and a positive team affective tone jointly reduce the gap between coworkers in relationship conflict.

**H3: Supervisory support and team affective tone will jointly moderate the negative effects of relationship conflicts with co-workers on co-workers' validation of creative ideas,**

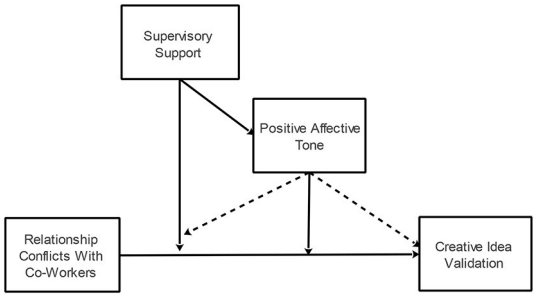


FIGURE 1
Research model.

**such that, relationship conflicts' negative impact on co-workers' validation of creative ideas is even less when supervisory support and team affective tone are high.**

Our research model is presented in Figure 1.

# Methodology

## Participants

The characteristics of the participants of this study provided an opportunity to test the proposed model in the health care sector of Pakistan. Previous researchers have used non-probability sampling by recruiting a variety of adequate participants (14, 77–79) for generalizability of their research findings. Therefore, follow owing these examples, in this research; we approached five public sector medical colleges of south-Punjab for data collection, to initiate the process of convenience sampling.

For sample selection, statistical power, significance level, effect size and the number of independent variables are important to take into account (80). When maximum number of independent variable in a model are two, in order to achieve a statistical power of 80% for detecting $R^2$ values of at least 0.1 with a significance level of 5%, at least participants needed are 90 (81, 82). In our study, data collection process was initiated with 578 participants, which is larger than the minimum sample size of 90 participants.

Common method variance is an issue related to survey studies, however, the temporal separation of data collection of study variables, reduce evaluation oppression, and protecting respondent anonymity can reduce the chances of common method variance issues (83). As a procedural technique, following previous research, we divided data collection process into two points in time, we maintained respondent anonymity by allocating dummy codes to the respondents, and reduced evaluation apprehension by sending direct email to the respondents so that they may respond at a time and place of their convenience (84). Additionally we also performed Harman's single factor test, the value for percentage of variance was 24.735% of the total variance which indicates that common method biases were not a serious problem (85).

## Sample and data collection

All enrolled final year generic nursing students and medical dispensers of public sector nursing colleges (Nishtar Medical College, Multan; B.V. Hospital, Bahawalpur; DHQ Hospital, Layyah; DHQ Hospital, D.G.Khan; DHQ Hospital, Mianwali) of south-Punjab, Pakistan ($N = 578$). Initially, in a formal meeting, the purpose and significance of the study were discussed with relevant District Health Officers (DHO) and Medical Supertendents. The data collection process was divided into two points in time with the multisource collection technique. To identify the individual response with leaders' and co-workers' responses, we assigned dummy codes to all the respondents. In introductory seminars at all of the hospitals, we introduced our research and then the HR officer sent an introductory email to all 578 respondents and their 47 relevant supervisors; we then initiated our data collection process. We emailed employees for their responses about relationship conflicts with co-workers and supervisory support (Time 1). This technique of data collection also ensured the safety of the participants at the time of covid-19 pandemic when social distancing was a requirement. We received an initial response from 497 respondents, and then we initiated the second phase of data collection, which was more like a social network analysis. After 4 weeks, we sent questionnaires to those 497 respondents who had already provided their responses at time 1 (Time 2). The response was received from 431 respondents about creative idea validation and team affective tone. Data for all of the control variables were also obtained at the time 1.

For the final data set of this study, we focused on the matched data of employees and their co-workers. The mismatched and incomplete response was not included in the final data set which yielded a response of 243. Due to the complex nature of response required at time 2, the final data set dropped from 497 to 243. A final qualified sample of 243 was used in all of this study's analyses and model testing. In the final qualified sample, 34.5 were males, and 65.5 were females; the average experience working in the healthcare sector was 5 years. We used the maximum likelihood method for missing values, which is a more robust technique compared to list-wise deletion, pair wise deletion, mean replacement, or multiple imputation methods (86–88).

## Measures

### Relationship conflict with co-workers

Relationship conflict with co-workers was measured on a self-reporting measure of three items-five points Likert type scale (46, 89). The three items of the scale were "How strong is your personal- conflict with your co-workers?"; "How strong is your personality-based conflict with your co-workers"; and "How strong is your personal friction with your co-workers?." Scale items range from 1 = "Strongly disagree" to 5 = "Strongly agree." ($\alpha = 0.86$).

### Idea validation

Coworker's rated idea validation was measured as the number of co-workers with whom focal employee interacts as a part of their job with five items-five point Likert type scale (3). Egocentric network technique was used using name generation and interpreter method. As the first step of this method, for name generation, the employees were asked to recall and list down names of the co-workers of their choice based on the criteria: a) with whom they have to interact for task-related activities; b) whose feedback and support is essential to complete work, and c) who are dependent upon them to complete their task. In the interpreter step, we asked the respondents to provide data for co-workers on their list for their creative idea validation. To mitigate any social concern, we did not restrict them to rate every member of their work unit. Sample items for the scale are "I provide my opinion to the focal employee about his/her new ideas.," "I provide feedback to the focal employee about the feasibility of his/her new ideas.", and "I talk to the focal employee about his ideas to see if they will work." To calculate creative idea validation for a focal employee, consistent with previous research, we used UCINET 6.347 (90), which measures central tendency (91).

### Supervisory support

Supervisory support was measured with four items-five point Likert type scale (50, 92). Sample items include "How true is it that your supervisor is warm and friendly when you have problems?" and "How true is it that your supervisor shows approval when you have done well?" Scale items range from 1 = "Strongly disagree" to 5 = "Strongly agree" ($\alpha = 0.89$).

### Positive affective tone

Positive affective tone was measured with PANAS scales (71, 93) with five items-five point Likert type scale. As our focus in this research was positive team affective tone, therefore, consistent with previous research, we used words such as excited, enthusiastic, and inspired (94). We asked the respondents about their feelings when they think or talk about their work team ($\alpha = 0.79$).

### Control variables

In this study, we controlled for demographic and contextual variables that may affect and provide alternative explanations of creative idea validation for the focal employee. We controlled for gender and professional experience with one question each. We further controlled for psychological safety with seven items-five point Likert type scale (95) ($\alpha = 0.93$), autonomy with four items-five point Likert type scale (96) ($\alpha = 0.87$), extrinsic motivation with twelve items-five point Likert type scale (97) ($\alpha = 0.78$), and intrinsic motivation with four items-five point Likert type scale (98) ($\alpha = 0.84$).

## Analytical strategy

Mplus 7.0 was used in all of the analyses of this study. We collected data from generic nursing students who were nested into other teams under different supervisors based on their assigned healthcare assignments. In situations like this, the use of simple regression techniques could underestimate the standard error; additionally, there could be potential interdependence among the study variables (99). Scholars recommended using random coefficients analysis techniques (100). In our sample, all variables were operated at a single level of analyses; thus, we used the random coefficients modeling technique at the individual level with Mplus 7.0 for random coefficients. Researchers have already used this technique for data with similar characteristics (15, 77). For model fit indicators, the output produced by Mplus cannot be used in a regular way; therefore we also have to perform the Satorra-Bentler difference test using the log-likelihood method for chi-square difference testing (101). Before any analysis, we grand mean centered all the variables of this study; additionally, to reduce chances of multicollinearity for interaction variables, we also grand mean centered interaction variables (102).

## Data analyses

# Results

Descriptive statistics and zero-order correlation among study variables are shown in Table 1. Although, results of Satorra-Bentler difference test using log-likelihood method for chi-square difference test performed for model fit indicators are presented in Table 2, conventional model fit indicators for

TABLE 1 Means, standard deviation, and correlation among study variables.

| Variable | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gender | 0.66 | 0.48 | | | | | | | | | |
| 2. Professional experience | 6.09 | 2.10 | 0.045 | | | | | | | | |
| 3. Psychological safety | 3.74 | 0.85 | −0.025 | 0.026 | | | | | | | |
| 4. Autonomy | 3.40 | 0.97 | −0.013 | 0.012 | 0.474** | | | | | | |
| 5. Extrinsic motivation | 3.91 | 1.47 | −0.130* | −0.106 | −0.201** | −0.072 | | | | | |
| 6. Intrinsic motivation | 3.70 | 1.31 | 0.008 | 0.067 | 0.179** | 0.128* | 0.039 | | | | |
| 7. Relationship conflict with co–workers | 3.77 | 1.59 | 0.049 | 0.075 | 0.094 | 0.007 | 0.032 | 0.279** | | | |
| 8. Supervisory support | 3.86 | 1.52 | 0.059 | 0.110 | 0.127* | −0.007 | 0.027 | 0.087** | 0.196** | | |
| 9. Positive affective tone | 3.69 | 0.86 | 0.012 | 0.149* | −0.023 | −0.159** | 0.067 | 0.123** | 0.478** | 0.089** | |
| 10.Creative idea validation | 3.80 | 0.75 | −0.054 | −0.090 | −0.195** | −0.153** | 0.109 | −0.103 | −0.137* | −0.086 | 0.099 |

Observations = 243. Clusters = 41. Gender was coded as 0 = Female, 1 = Male. Professional Experience was measured in years.
*p < 0.10. **p < 0.05. ***p < 0.01.

the final model are also provided. The conventional statistics for final model, Chi-square baseline model $\chi^2 = 58.979$, 13, $p < 0.001$, loglikelihood for alternate model = −296.991, with scaling correction factor 1.104, loglikelihood for null model = −322.53, with scaling correction factor 2.017, CFI = 0.99, TLI 0.99, error variance for null model = 0.064, error variance for alternate model = 0.049, and RMSEA = 0.0001 with construct reliability of 0.83 for average variance extracted (AVE) indicated a good fit of the model to the data.

## Test of hypothesis

Using Mplus 7.0 for the random coefficient model; we regressed gender, professional experience, psychological safety, autonomy, extrinsic motivation, intrinsic motivation as control variables along with the relationship conflicts with co-workers as an independent variable on creative idea validation to confirm the direct effect of relationship conflicts with co-workers on their validation of creative ideas. The results of this analysis are presented in table2-model1, the significant coefficient **($\beta = -0.131$, $p \leq 0.05$)** confirmed the negative effects of relationship conflicts with co-workers on creative idea validation, thereby providing support to hypothesis 1 of this study. Although not hypothesized, in table2-model2, we regressed gender, professional experience, psychological safety, autonomy, and extrinsic motivation, intrinsic motivation as control variables, and relationship conflicts with co-workers and supervisory support to confirm the direct effects of supervisory support on creative idea validation. The significant coefficient **($\beta = 0.300$, $p \leq 0.001$)** confirmed the positive impact of supervisory support on the validation of creative ideas among co-workers.

We followed a three-step procedure for moderation analysis (102) and a three-step procedure for mediation (103). The indirect effect option could not be considered for our models as the bootstrap option cannot be used with random coefficient analyses (101). We regressed gender, professional experience, psychological safety, autonomy, extrinsic motivation, and intrinsic motivation as control variables, relationship conflicts with co-workers, supervisory support, and interaction of relationship conflicts with co-workers and supervisory support on a positive affective tone. We found a significant coefficient **($\beta = 0.440$, $p \leq 0.001$)** of supervisory support and a significant coefficient **($\beta = 0.047$, $p \leq 0.001$)** of the interaction term representing relationship conflicts with co-workers and supervisory support, which are presented in table2-model3.

We then regressed gender, professional experience, psychological safety, autonomy, extrinsic motivation, and intrinsic motivation as control variables, relationship conflicts with co-workers, supervisory support, and interaction of relationship conflicts with co-workers and supervisory support on creative idea validation. Significant coefficient confirmed the moderation of supervisory support **($\beta = 0.035$, $p \leq 0.001$)** on the relationship between relationship conflicts with co-workers on their creative idea validation. The moderation of supervisory support attenuates the negative effects of relationship conflicts with co-workers on their validation of creative ideas. The moderating effects are presented in table2-model4 and shown in Figure 2, the plot of interaction suggested that high supervisory support will have a high positive impact on the relationship between relationship conflicts with co-workers and their creative idea validation. Even low supervisory support will positively affect the relationship between relationship conflicts with co-workers and their creative idea validation.

We then regressed gender, professional experience, psychological safety, autonomy, extrinsic motivation, intrinsic motivation as control variables along with relationship conflicts with co-workers, supervisory support, the interaction of relationship conflicts with co-workers and supervisory support, positive affective tone, and interaction of relationship conflicts

TABLE 2 Random coefficients regression analyses.

| Predictor | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | | Model 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Creative idea validation | | Creative idea validation | | Positive affective tone | | Creative idea validation | | Creative idea validation | | Creative idea validation | |
| | **Estimate** | **SE** | **Estimate** | **SE** | **Estimate** | **SE** | **Estimate** | **SE** | **Estimate** | **SE** | **Estimate** | **SE** |
| Gender | −0.056 | 0.080 | −0.053 | 0.046 | −0.046 | 0.043 | −0.062 | 0.082 | −0.037 | 0.081 | −0.036 | 0.080 |
| Professional experience | −0.024 | 0.022 | 0.032* | 0.013 | 0.038** | 0.013 | −0.023 | 0.023 | −0.035 | 0.022 | −0.035 | 0.022 |
| Psychological safety | −0.122 | 0.077 | −0.061 | 0.044 | −0.007 | 0.045 | −0.092 | 0.080 | −0.092 | 0.077 | −0.111 | 0.081 |
| Autonomy | −0.080 | 0.053 | −0.133*** | 0.035 | −0.110*** | 0.031 | −0.047 | 0.052 | −0.012 | 0.053 | −0.006 | 0.055 |
| Extrinsic motivation | 0.032 | 0.033 | 0.014 | 0.027 | 0.007 | 0.025 | 0.027 | 0.029 | 0.026 | 0.026 | 0.029 | 0.026 |
| Intrinsic motivation | 0.105 | 0.080 | 0.128 | 0.097 | 0.148 | 0.092 | 0.062 | 0.079 | 0.005 | 0.075 | −0.011 | 0.080 |
| Relationship conflict with co–workers | **−0.131*** | **0.063** | 0.048 | 0.090 | 0.258*** | 0.081 | −0.044 | 0.107 | −0.317 | 0.216 | −0.627 | 0.563 |
| Supervisory support | | | **0.300***** | **0.077** | **0.440***** | **0.078** | 0.230*** | 0.078 | −0.058 | 0.167 | −0.249 | 0.390 |
| Relationship conflict with co–workers x supervisory support | | | | | 0.047*** | 0.007 | **0.035*** | **0.018** | 0.012 | 0.038 | 0.167 | 0.108 |
| Positive affective tone | | | | | | | | | 0.429* | 0.216 | 0.417 | 0.362 |
| Relationship conflict with co–workers x positive affective tone | | | | | | | | | **0.096**** | **0.040** | 0.079 | 0.129 |
| Supervisory support X positive affective tone | | | | | | | | | | | 0.142 | 0.122 |
| Relationship conflict with co–workers X Supervisory support X positive affective tone | | | | | | | | | | | **0.467**** | **0.062** |
| Δ $\chi$ 2 (Δdf) | 3619.97 (21) | | 3745.84(20) | | 3230.02(19) | | 3412.74(19) | | 2161.16(17) | | 58.32(12) | |
| Δ $R^2$ | 0.171 | | 0.187 | | 0.546 | | 0.187 | | 0.250 | | 0.234 | |

Observations = 243. Clusters = 41. Gender was coded as 0 = Female, 1 = Male. Professional Experience was measured in years.
Δ $\chi$ 2 refers to Satorra–Bentler scaled chi–square difference test Muthén and Muthén (1998–2010). Δdf is change in degree of freedom.
Δ $R^2$ is degree of reduction in error variance.
*p < 0.10. **p <0.05. ***p <0.01.
Bold value indicates significant and important values model.





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with co-workers and positive affective tone on creative idea validation. In the presence of supervisory support and the interaction of relationship conflicts with co-workers and supervisory support, the interaction term of the relationship conflicts with co-workers and positive affective tone confirmed the moderating effect of positive affective tone **($\beta = 0.096$, $p \leq 0.01$).** The moderation of positive affective tone attenuates the negative effects of relationship conflicts with co-workers on their validation of creative ideas. The moderating effects are presented in table2-model5 and shown in Figure 3; the plot of interaction suggested that high positive affective tone positively; however, low positive affective tone negatively moderates the relationship between relationship conflicts with co-workers and their creative idea validation.

Finally, we tested a three-way interaction of the relationship conflicts with co-workers, supervisory support, and positive affective tone for its effects on co-workers' creative idea validation. We regressed gender, professional experience, psychological safety, autonomy, extrinsic motivation, intrinsic motivation as control variables along with relationship conflicts with co-workers, supervisory support, the interaction of relationship conflicts with co-workers and supervisory support, positive affective tone, and interaction of relationship conflicts with co-workers and positive affective tone, the interaction of supervisory support and positive affective tone, and a three-way interaction term of the relationship conflicts with co-workers, supervisory support, and positive affective tone on creative idea validation. Significant coefficient confirmed the effects of three-way interaction term on co-workers' validation of creative ideas **($\beta = 0.467$, $p \leq 0.05$)**. The results are presented in table2-model6 and shown in Figure 4. The plot of three-way interaction suggested that high supervisory support and high positive affective tone will positively affect the relationship between relationship conflicts with co-workers and their validation of creative ideas, negative otherwise. We then confirmed the pattern of the results by slope difference tests (104). The results confirmed that high supervisory support and high positive affective tone slope was more positively significant ($t = 2.93$, $p < 0.001$) than high supervisory support and low positive affective tone ($t = 2.32$, $p < 0.05$), low supervisory support and high positive affective tone ($t = 2.13$, $p < 0.05$), and low supervisory support and low positive affective tone ($t = 2.06$, $p < 0.05$). This three-way interaction provided a clearer and accurate picture that even in the presence of relationship conflicts among co-workers, creative individuals will get their ideas validated by their co-workers when there is high supervisory support and high positive affective among them co-workers at work. The results can also be interpreted in another way that high supervisory support will create an environment of positive affective tone among co-workers that increases their validation of creative ideas even when they have relationship conflicts among them. Empirical findings of this study support all predictions of this study.

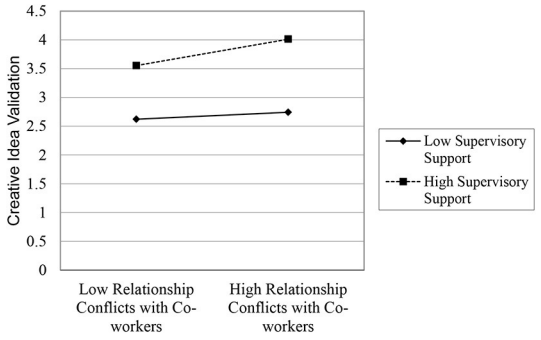


FIGURE 2
Plot of interaction between relationship conflict with co-workers and supervisory support.

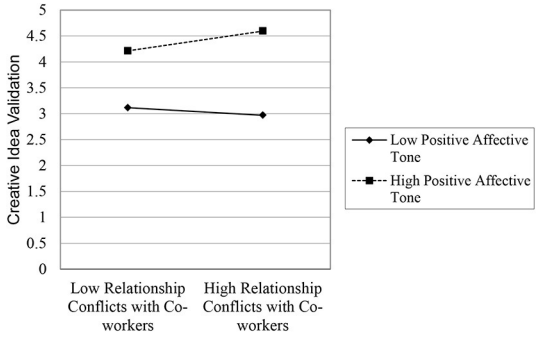


FIGURE 3
Plot of interaction between relationship conflict with co-workers and positive affective tone.

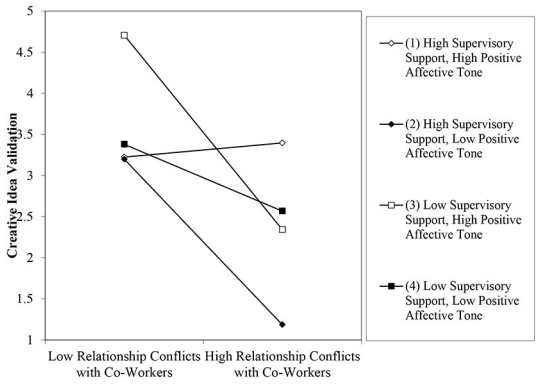


FIGURE 4
Plot of interaction between relationship conflicts with co-workers, supervisory support, and positive affective tone.

## Discussion

The main goal of this research was to uncover the possible effects of relationship conflicts among co-workers and their

validation of creative ideas. First, negative effects of relationship conflicts on validation of creative ideas was found, when creative individuals are in relationship conflicts with others they are less likely to get their ideas validated by their co-workers. Second, support from the supervisors attenuates this negative relationship such that supportive supervisors foster an environment of positive affective tone in their work units which is beneficial for validation of creative ideas even in presence of relationship conflicts among co-workers.

Our results can be summarized as follows; first, we found that relationship conflicts with co-workers are negatively related to their validation of creative ideas. Second, supervisory support attenuates the negative effects of relationship conflicts with co-workers with their validation of creative ideas. The relationship is positive in the case of high supervisory support. Third, we found that positive affective tone attenuates the negative effects of relationship conflicts with co-workers with their validation of creative ideas. The relationship is positive in case of high positive affective tone; however, negative otherwise. Fourth, positive affective tone emerged as a positive predictor of creative idea validation. Fifth, positive affective tone affected by supervisory support attenuated the negative relationship between relationship conflicts with co-workers and their validation of creative ideas. Finally, the relationship between relationship conflicts with co-workers and their validation of creative ideas are more positive when both supervisory support and positive affective tone are high, however, low otherwise.

## Research contributions

### Practical contributions

Employees can be creative in all functional areas of their jobs (16). Although creativity research has grown exponentially in enhancing our knowledge about the creative process (16), this knowledge largely rests on the theoretical foundations (105). Increasing demand to understand why the pace of innovation is still slow at organizations (106, 107) and does theoretically established concepts relate to actual performance (108). Thus, understanding the conflict side of creativity has practical implications. This study will help policymakers understand what might be hindering the transfer of creative ideas to influential others (Leaders, Managers, etc.) and what they need to do to enhance the creative pool of their organizations.

Although task conflicts have been found to support creativity, proper management of relationship conflicts will also benefit the creative process. Thus, developing strategies of relationship conflict management will also increase the creative potential of the organizations. Specifically, developing corporate-level strategies for supervisory support and team affective tone will increase the likelihood of co-workers' recognition and validation of conflict-provoking creative individuals' ideas for the benefit of organizations. The contingency perspective of this research also brings some valuable practical contributions. Although developing an environment that fosters creativity is vital for organizations, they also need to develop strategies to manage relationship conflicts among co-workers due to the creative environment. Therefore, we also recommend, organizations consider a relationship perspective when developing an environment for creativity: an environment based on mutual trust and respect so that a positive affective tone can establish with the support of the supervisors for the proper transferring of creative ideas to higher offices.

## Theoretical contributions

Building on belongingness theory (22), we have made some distinct contributions to the literature with this research. First, the primary contribution of this research lies in answering the fundamental question of how social conflicts of a conflict-provoking creative individual are related to the validation of ideas by peers. We built our conceptual model on belongingness theory. We uniquely integrated the contingency perspective of conflict literature from the lens of a supportive environment to answer how the odds of social conflicts with co-workers can be reduced in the creative process. Consistent with previous findings, we also found that odds of conflicts can be reduced if appropriately managed: the support from the supervisor and team members will attenuate the negative effects of conflicts on creative output (27, 109, 110). Additionally, previous research has established the role of team task conflicts and relationship conflicts in the creativity process (111). Empirical research has given little attention to understand the role of individual-level interpersonal conflicts in the innovative process (28, 112). To the best of our knowledge, the current study is the first empirical investigation of the relationship conflicts with co-workers and, as a reaction, its impact on their validation of creative ideas of that conflict-provoking creative individual.

Coworkers' presence and behavior matter in the creativity process (28). Interpersonal support and antagonism of co-workers subsequently influence the individual employee outcomes (113). Research has established that co-worker behaviors, support, and antagonism shape the social work environment for an individual. Organizations have moved from routine individual tasks to more complex and collective tasks (114), where work is mainly done based on interpersonal relationships (115) for goal achievements (116). But the reality is, interpersonal conflict is rife in modern organizations; employees have to work in organizations where they have to face more conflicts than supportive behaviors (117) (Psychometrics, 2009). Thus, investigating relationship conflicts as dysfunctional interpersonal interactions of co-workers was essential to examine for their validation of creative ideas.

The dual-process communication between coworkers plays a significant role in the creative idea validation of their

colleagues. In this study, we have examined the effects of conflict on creative idea validation and identify the importance of the dual process of communication, including (verbal and non-verbal cues). We have extended the literature by empirically identifying the buffering effect of supervisory support and positive team affective tone acting as verbal and non-verbal cues when colleagues have to validate the creative ideas of those with whom they conflict. This research offers a more comprehensive understanding of the mechanism behind the creative idea validation in horizontal relationships in organizations.

Another theoretical implication we find is the support of the proposed moderated mediation relationship. We find that when employees have higher supervisory support, it attenuates the harmful effects of relationship conflicts with co-workers on their validation of creative ideas through a positive team affective tone. Therefore, our research illustrates that employees who enjoy supervisory support can manage and regulate the negative effects of relationship conflicts. Past research has identified the positive impact of supervisory support on employee creativity (48) and innovation (49). Similarly, team effective tone has also been identified as an antecedent of creative idea validation (68, 73). Hence, there is a need to identify the underlying mechanism of how supervisory support results in creative idea validation by co-workers. Our research reveals the moderated mediation effects of supervisory support and positive team affective tone that helps to mitigate the harmful impact of relationship conflicts on creative idea validation by coworkers.

Finally, creativity researchers focused predominantly on investigating variance-focused creativity, whereas selection-focused creativity has received less attention (3). Therefore, creativity research needs to pay more attention to the receiving side of creativity (33). Thus, contemporary research on creativity demands an understanding of the factors that may hinder creative process due to interpersonal conflicts. This study also contributes to the receiving side of creativity research by investigating the detrimental effects of relationship conflicts for validation of creative ideas: the selection-focused receiving side of creativity process.

## Limitations and future research direction

Although we have made some valuable contributions to this research, this research should be considered light of limitations. The basic limitation of this study lies in the research design; the survey-based study makes it vulnerable to alternative explanations of the hypothesized relationships. A combination of correlation research and an experiment with different operationalization, controls, and manipulation brought a more precise and accurate picture of the causal inferences. Although we have strong theoretical reason to expect that relationship conflicts with co-workers would precede creative idea validation and not vice versa (22); causal inference can be explained in a better way in a combination of correlation study and an experiment.

Additionally, the conventional use of multiple data sources and dividing the data collection process into two points in time reduced the chances of common method biases; these two conservative steps also reduced sample size from 578 observations and 47 clusters to 243 observations and 41 clusters. The context of the study is also a potential limitation, as the data was collected from IT engineers of a software house; the employees in our sample were nested into different workgroups, which were distinguished based on their functional assignments. Therefore, we are unaware that the relationship among the study variables exists in other industries or from the sample with employees of different hierarchical levels. Thus, we recommend, further research should explore and operationalize the relationship among the variables in sectors other than information technology and the sample collected on multiple hierarchical levels.

## 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 Dr. Zeeshan Ahmed. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

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

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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EDITED BY
Emanuele Cannizzaro,
University of Palermo, Italy

REVIEWED BY
Perengki Susanto,
Padang State University, Indonesia
Giovanna Parmigiani,
Sapienza University of Rome, Italy
Nicola Mucci,
University of Florence, Italy

*CORRESPONDENCE
Luigi Vimercati
luigi.vimercati@uniba.it

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# Organizational wellbeing: A model of a new Apulian COVID-19 designated hospital

Luigi Vimercati[1,2]*, Enza Sabrina Silvana Cannone[1,2], Stefania Sponselli[1,2], Antonio Caputi[1,2], Giovanni Migliore[3], Antonio Daleno[3], Anna Maria Minicucci[3], Gabriella Milone[3], Lorenzo Spagnolo[4], Antonella Pipoli[1,2] and Luigi De Maria[1,2]

[1]Section of Occupational Medicine, Interdisciplinary Department of Medicine, University of Bari, Bari, Italy, [2]Occupational Medicine Unit, University Hospital of Bari, Bari, Italy, [3]Hospital Direction, University Hospital of Bari, Bari, Italy, [4]Section of Legal Medicine, Interdisciplinary Department of Medicine, University of Bari, Bari, Italy

**Background:** Work environment characteristics have an important impact on organizational wellbeing in health care facilities. In the Apulia Region, a new COVID-19 hospital was planned, designated and built in a few weeks for the treatment of patients infected with SARS-CoV-2. To our knowledge, this hospital, together with "Fiera Hospital" in Milan, are two of the few buildings worldwide that have been converted into new health care facilities with intensive care center units to treat COVID-19 patients, and this is the first study assessing organizational wellbeing in a newly designated COVID-19 hospital.

**Aims:** To detect and assess the strong points, criticality, and perceptions of wellbeing/discomfort of health care workers engaged in the management of the current health emergency.

**Method:** The study was conducted on 188 health care workers, with the "Multidimensional Organizational Health Questionnaire."

**Results:** We found an overall positive level of organizational wellbeing. The more positive dimensions were "Collaboration between colleagues," "Organizational efficiency" and "Room Comfort." Conflict situations in the workplace were poorly perceived. A very low rate of absenteeism from work was also observed.

**Conclusions:** Our results show the effectiveness of the organizational model adopted in the management of the COVID-19 hospital, especially in view of the work and emotional overload of the personnel called to face the epidemiological emergency on the frontline, which did not adversely affect the psychophysical conditions of the workers. The success of this model is related to the coexistence of all levels of care required during any type of health emergency in a single structure, paying particular attention to the architectural, functional, and procedural aspects of health care and to the so-called "humanization" of care.

KEYWORDS

**organizational wellbeing, COVID-19 hospital, health care workers, job performance, job satisfaction**

# Introduction

In Italy, as in most European countries, legislation underlined the importance of ensuring organizational wellbeing, health and quality of life in the workplace.

Organizational wellbeing can be defined as "*the ability of an organization not only to be effective and productive but also to grow and develop, ensuring an adequate degree of physical and psychological wellbeing of its workers*" (1).

Several studies have shown that work environment characteristics have an important impact on organizational wellbeing in health care organizations (2–5), producing significant physical and emotional consequences for health care workers (2, 6), and affecting the quality of job performance and patient care (2, 7–9). In fact, whenever a health organization creates a working environment that encourages organizational wellbeing, workers engage in positive behaviors that contribute to improving the quality of care (2, 10).

Essentially, an organization can be described as "healthy" if its workers are fully satisfied and consider the organization to be effective and productive (1, 2, 11).

Several authors have shown that work-related stress, a lack of job satisfaction and poor organizational wellbeing may lead to issues such as absenteeism (12), a reduction in productivity, low motivation, limited expectations, a lack of commitment, and increased complaints from patients/users (11). Furthermore, several studies found that these conditions negatively affect worker health, increasing the risk of psychosomatic disorders, emotional exhaustion and burnout. In contrast, other scientific publications have indicated that in workplaces in which employees are satisfied, there are several benefits to employees' psychophysical health and they have increased positive feelings (happiness, general satisfaction, motivation and productivity) (2).

Some studies affirm that the kind of job, interprofessional relationships, the level of responsibility, an adequate level of decision-making autonomy and career development affect the level of occupational wellbeing and job satisfaction. Conversely, variables such as an authoritarian management style, inadequate planning and organization of care activities, organizational constraints, heavy workloads, interpersonal conflict and hierarchical interprofessional relationships may result in job dissatisfaction and discomfort (2, 11).

Following the advent of the health emergency resulting from the spread of the COVID-19 pandemic, health care companies had to implement rapid changes, affecting both the workload of health professionals and company organizations, resulting in a complete disruption of the work routine.

All these factors, together with the restrictions and social isolation imposed by the lockdown period and pandemic, resulted in physical and psychological damage to health workers, compromising the so-called "organizational wellness."

Indeed, according to different scientific studies, during the pandemic, health workers have suffered disorders such as anxiety, depression, and circadian rhythm disruption (13, 14) more often than the general population, and overwork was the main factor responsible for the onset of stress and psychological discomfort (15).

Thus, health and quality of life in the workplace have become of great interest in health management, requiring an analysis of workers' needs (16) and health prevention strategies that focuses particularly on necessities that emerged during the COVID-19 pandemic. It is also important to evaluate the physical and mental states of health workers, as their health conditions may affect the effectiveness of patient treatment and protection (2).

In Bari, southern Italy, a new COVID-19 hospital was built for treatment of patients infected with SARS-CoV-2. This hospital was commissioned by the Apulia Region in collaboration with the University Hospital Policlinico of Bari and built in the pavilions of "Fiera del Levante," a fair quartier of Bari, where an international trade fair takes place every year. To our knowledge, this hospital, together with "Fiera Hospital" in Milan, are two of the few buildings worldwide that have been converted into new health care facilities with intensive care center units to treat COVID-19 patients. This has led to the lack of studies in literature on the role and impact of new COVID-19 designated hospitals on organizational wellbeing and physical and mental states of health workers.

Therefore, the aim of this study was to detect and assess the strong points, criticality, and perceptions of wellbeing/discomfort of health professionals engaged in the management of the current health emergency in the "Fiera" COVID-19 designated hospital.

# Materials and methods

## Participants and procedure

The survey was conducted by the Complex Operative Unit of Occupational Medicine of the University Hospital of Bari, in collaboration with the Health Department of Presidium for maxi-emergencies located in the pavilions of Bari's "Fiera del Levante."

In June 2021, an e-mail containing information about the aim of the research, the tool used, and the method and timing for the collection of questionnaires was sent to all 198 health professionals employed in the COVID-19 Hospital. We used the e-mail survey method in order to collect data on the largest population possible, in the shortest time and at the lowest cost, without taking too much time away from the health care workers involved in the fight against COVID-19. Furthermore, this survey has already been used by several public administrations.

From the 7$^{th}$ to 14$^{th}$ of June 2021, during the third SARS-CoV-2 epidemic wave in Apulia Region, after providing written informed consent, a total of 188 health care workers (95% adhesion rate) participants completed, on a voluntary and anonymous basis, the questionnaire received by e-mail. A total

of 10 health care workers did not provide written informed consent within the deadline and were excluded from the study.

All subjects were informed that data from the research protocol would be treated in an anonymous and collective way with scientific methods and for scientific purposes in accordance with the principles of the Declaration of Helsinki. Ethical approval was not necessary because all medical and instrumental examinations were performed according to Italian law concerning the protection of workers exposed to occupational risks (D.Lgs. 81/2008).

## Measures

The detection tool used was the "Multidimensional Organizational Health Questionnaire" (MOHQ) (17). This validated questionnaire, designed by the Department of Psychology of the University "La Sapienza" of Rome, was developed to define the "health state" of an organization by analyzing the relationship between individual and workplace contexts and identifying areas that need changes to improve working conditions.

The questionnaire explores the 12 dimensions of organizational wellbeing and each of the investigated dimensions corresponds to precise items in the questionnaire (Table 1).

The updated version of the questionnaire consists of 67 questions divided into eight parts. The questionnaire items included personal, environmental and work history data (questions 1 to 15), characteristics of the working environment (questions 16 to 56), workplace safety (questions 57 and 58), characteristics of the job and tolerability of assigned tasks (questions 59 and 60), feelings experienced in workplace (questions 61 to 63), psychophysical wellbeing of the worker (questions 64 and 65), openness to innovation (question 66), and suggestions to improve the work organization (question 67).

TABLE 1 Correspondence between "organizational wellbeing dimensions" and questionnaire items.

| Correspondence between "organizational wellbeing dimensions" and questionnaire items | | |
|---|---|---|
| **N°** | **Factor** | **Questions in the questionnaire** |
| 1 | Management support | 24-27-29-32-33-37-39-44-50 |
| 2 | Collaboration between colleagues | 19-22-40-49-52-53 |
| 3 | Organizational fairness | 34-38-48-54 |
| 4 | Organizational efficiency | 17-18-20-23-26-28-30-46-47-56 |
| 5 | Conflict management | 21-31-41-51 |
| 6 | Stress perception | 25-45-55 |
| 7 | Job demands | 59 |
| 8 | Room comfort | 16 |
| 9 | Job security | 57-58 |
| 10 | Openness to innovation | 66 |
| 11 | Satisfaction | 61-62 |
| 12 | Psychophysical disorders | 64 |

In all sections of the questionnaire, excluding the personal data and suggestions, the information was collected through a 4-point Likert measuring scale, ranging from a minimum of NEVER (score equal to 1) to a maximum of OFTEN (score equal to 4).

The Likert scale allowed us to calculate the average score for each of the 12 dimensions. Generally, a high score coincides with a positive evaluation of the dimension. The correspondence between a high score and positivity does not always occur for all dimensions. In fact, for some dimensions (conflict management, stress perception, job demands, negative indicators of satisfaction, psychophysical disorders), it was necessary to reverse the method of scoring to standardize the reading of the results. Therefore, these indicators have a negative connotation if they are perceived as very present in the organizational context.

The overall results of the whole sample are summarized into the "General Profile," which is representative of the different values recorded in each of the organizational health dimensions. The procedure used to define the "General Profile" required the calculation of the average value for each dimension; then, the mean value of the graph for the "General profile" was obtained by summing the average score of each dimension and, subsequently, dividing it by the total number of dimensions.

The representation in a single graph ("General Profile") allowed an immediate comparison of the dimensions. Thus, all dimensions that exceed the general average value (shown in the graph with a dotted line) represent the fields perceived by the study population as most positive in relation to organizational wellbeing. In contrast, all dimensions with a score below the general average represent the fields that the study population perceived as critical.

In this study, data analysis was performed using IBM SPSS Statistics Version 26. We used descriptive statistics (percent, mean and standard deviation) and the chi-square test for data analysis.

$P < 0.05$ were considered statistically significant.

# Results

## Sample characteristics

The overall sample consisted of 188 health care workers. The mean age was 36.8 years. Table 2 shows the general characteristics of the study population.

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TABLE 2 General characteristics of the study population (n = 188).

| Factors | Absolute value | % |
|---|---|---|
| **Sex** | 188 | 100% |
| Female | 113 | 60.1% |
| Male | 74 | 39.4% |
| Not indicated | 1 | 0.5% |
| **Age** | 188 | 100% |
| <24 years | 30 | 16.0% |
| 25-34 years | 68 | 36.2% |
| 35-44 years | 33 | 17.5% |
| 45-54 years | 34 | 18.1% |
| >55 years | 22 | 11.7% |
| Not indicated | 1 | 0.5% |
| **Qualification** | 188 | 100% |
| Elementary school | 2 | 1.1% |
| Junior high school | 20 | 10.6% |
| High school | 32 | 17.0% |
| University degree | 133 | 70.8% |
| Not indicated | 1 | 0.5% |
| **Civil status** | 188 | 100% |
| Unmarried | 96 | 51.1% |
| Married/cohabiting | 78 | 41.5% |
| Separated/divorced | 10 | 5.3% |
| Widowed | 1 | 0.5% |
| Not indicated | 3 | 1.6% |
| **Job Position** | 188 | 100% |
| Health care staff | 136 | 72.3% |
| Management | 50 | 26.6% |
| Not indicated | 2 | 1.1% |
| **Working time** | 188 | 100% |
| Full-time | 177 | 94.1% |
| Part-time | 9 | 4.8% |
| Not indicated | 2 | 1.1% |
| **Contract type** | 188 | 100% |
| Fixed term | 127 | 67,5% |
| Indefinite duration | 59 | 31.4% |
| Not indicated | 2 | 1.1% |
| **Length of service** | 188 | 100% |
| <1 year | 27 | 14.4% |
| 1-4 years | 55 | 29.2% |
| 5-9 years | 28 | 14.9% |
| 10-14 years | 10 | 5.3% |
| 15-20 years | 25 | 13.3% |
| >20 years | 27 | 14.4% |
| Not indicated | 16 | 8.5% |

## General profile

The general profile (Figure 1) represents the average score obtained by the whole sample in each of the 12 dimensions. It gives an indicative "picture" of organizational wellbeing. The dotted line represents the general average value of the 12 dimensions (3.3).

This value indicates a positive level of organizational wellbeing, according to the interpretative parameters suggested by the authors of the MOHQ questionnaire (Table 3).

A histogram analysis (Figure 1) showed that the dimensions with values lower than the general average were "*Job demands*" (2.3), "*Stress perception*" (2.3), and "*Organizational fairness*" (3.2). "*Psychophysical disorders*" was in line with the average (3.3). The remaining dimensions had values that exceeded the general average; in particular, "*Collaboration between colleagues*" (3.7), "*Organizational efficiency*" (3.6) and "*Room Comfort*" (3.6) showed the highest values.

Furthermore, comparing the same dimensions with the cut-off of 2.6 suggested by the authors of the MQHQ questionnaire, only "*Job demands*" (2.3) and "*Stress perception*" (2.3) showed a negative evaluation.

## Disaggregated profiles

### Critical dimensions

The analysis of the "*Job demands*" dimension (Table 4) showed an average value of 2.3. In particular, the factor with the lowest average value was "*Direct responsibility for work*" (1.6±0.68), followed by "*Frequent contact with people*" (1.9±0.78). In contrast, the "*Isolation*" factor showed the highest average value (3.3±0.85), comparable to the mean value of the general profile.

The evaluation of the connection between demographic characteristics and the perception of job demands (Table 5) showed that single civil status had a negative significant relationship with the perception of job demands ($p < 0.038$).

The "*Stress perception*" dimension (Table 6) showed an average value of 2.3. The analysis of the data underlines that the most critical aspect is the perception that "*The job totally consumes me*" (1.8 ± 0.82). Moreover, the other factors ("*The work tasks to be performed cause excessive fatigue*" and "*The work tasks to be performed cause excessive stress*") also showed an average value that was lower than the general value (2.4 ± 0.8 and 2.6 ± 0.94, respectively).

The evaluation of the relationship between demographic characteristics and stress perception (Table 7) showed that subjects with a length of service <1 year had the lowest perception of work-related stress ($p < 0.011$).

The assessment of "*Organizational fairness*" (Table 8) showed an average value of 3.2, compared to the average value of the General Profile. However, the "*Commitment to work and personal initiatives are appreciated*" item showed a mean value of 3.4 ± 0.75, which was higher than the general average value of the 12 dimensions.

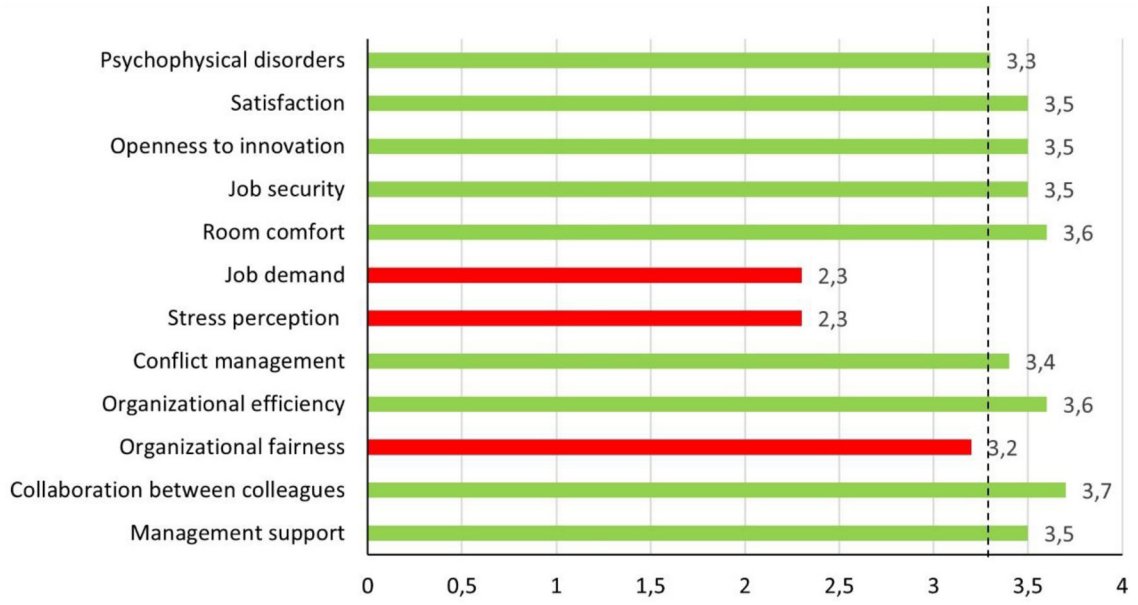


FIGURE 1
General profile. The dotted line represents the general average value of the 12 dimensions (3.3).

TABLE 3 MOHQ: data interpretation criteria (17).

| Values | Interpretative parameters |
|---|---|
| >2.9 | Positive |
| 2.6–2.9 | Sufficient |
| <2.6 | Negative |

TABLE 4 Job demands*.

| | Average value ± standard deviation (SD) |
|---|---|
| Physical strain | 2.2 ± 0.86 |
| Mental strain | 2 ± 0.87 |
| Overwork | 2.5 ± 0.83 |
| Monotony or repetitiveness | 3 ± 0.83 |
| Emotional overload | 2.4 ± 1.01 |
| Isolation | 3.3 ± 0.85 |
| Frequent contact with people | 1.9 ± 0.78 |
| Direct responsibility for work | 1.6 ± 0.68 |
| Rigid rules and procedures | 2.3 ± 0.87 |

*For this indicator, it was necessary to reverse the method of scoring to standardize the reading of the results.

In the calculation of the mean value, the item "*Economic incentives are distributed on the basis of performance efficiency*" was excluded, as only 1% of the participants responded.

For the "stress perception" dimension, the relationship between demographic characteristics and organizational fairness (Table 9) showed that subjects with a length of service <1 year had a better perception of organizational fairness ($p < 0.011$).

## Favorable dimensions

The "*Collaboration between colleagues*" dimension was the dimension with the highest average value (3.7).

Table 10 shows the average value and standard deviation for each item of this dimension. We found very high values for the items concerning the availability of workers to meet the needs of the organization and their colleagues, with values of 3.85 ± 0.36 and 3.76 ± 0.50, respectively.

*The "organizational efficiency"* dimension (Table 11) showed a mean value of 3.6. The analysis of the items highlighted positive results, especially about the presence of tools and resources to better perform the job (3.77 ± 0.5) and job satisfaction (3.73 ± 0.52).

Table 12 represents the "*room comfort*" dimension. The assessment of the 8 factors showed average values that were constantly above the general mean value. We found that 81.4% of the workers appreciated the cleanliness and hygiene of the working rooms (average value 3.8 ± 0.49), while sanitary facilities, such as bathrooms and changing rooms, were assessed as excellent by 77.1% of the subjects (average value 3.73 ± 0.55).

Regarding the other dimensions evaluated, "*Satisfaction*" (Table 13), "*Openness to innovation*," "*Job security*" and "*Management support*" all showed an average value of 3.5. The

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TABLE 5 Demographic characteristics and job demand dimension.

| | Job demand dimension | | | | |
|---|---|---|---|---|---|
| | <3.3 | | ≥3.3 | | Chi-square test |
| | *n.* | % | *n.* | % | *p* |
| **Sex** | | | | | |
| Male (n. 74) | 27 | 36% | 47 | 64% | 0.499 |
| Female (n. 111) | 46 | 62% | 65 | 88% | |
| **Age (years)** | | | | | |
| <24 (n. 30) | 15 | 50 | 15 | 50 | 0.091 |
| 25–34 (n. 67) | 29 | 43 | 38 | 57 | |
| 35–44 (n. 33) | 16 | 48 | 17 | 51 | |
| 45–54 (n. 33) | 7 | 21 | 26 | 79 | |
| >55 (n. 22) | 7 | 32 | 15 | 68 | |
| **Marital status** | | | | | |
| Single (n. 96) | 47 | 49 | 49 | 51 | 0.038 |
| Married (n. 77) | 23 | 30 | 54 | 70 | |
| Divorced (n. 10) | 3 | 30 | 7 | 70 | |
| Widowed (n. 1) | 1 | 100 | 0 | 0 | |
| **Contract type** | | | | | |
| Temporary (n. 126) | 53 | 42 | 73 | 58 | 0.402 |
| Permanent (n. 59) | 21 | 36 | 38 | 64 | |
| **Working time regime** | | | | | |
| Part-time (n. 9) | 2 | 22 | 7 | 77 | 0.278 |
| Full-time (n. 176) | 71 | 40 | 105 | 60 | |
| **Position Director** | | | | | |
| Yes (n. 50) 0 | 24 | 48 | 26 | 52 | 0.148 |
| No (n. 135) | 49 | 36 | 86 | 64 | |
| **Working Seniority (years)** | | | | | |
| <1 (n. 27) | 7 | 26 | 20 | 74 | 0.109 |
| 1–4 (n. 55) | 25 | 45 | 30 | 54 | |
| 5–9 (n. 28) | 11 | 39 | 17 | 61 | |
| 10–14 (n. 10) | 7 | 70 | 3 | 30 | |
| 15–20 (n. 25) | 9 | 36 | 16 | 64 | |
| >20 (n. 27) | 7 | 26 | 20 | 74 | |

TABLE 6 Stress perception*.

| | Average value ± standard deviation (SD) |
|---|---|
| Excessive fatigue | 2.4 ± 0.80 |
| Excessive stress | 2.6 ± 0.94 |
| The job totally consumes me | 1.8 ± 0.82 |

*For this indicator, it was necessary to reverse the method of scoring to standardize the reading of the results.

"*Conflict management*" (dimension had a mean value of 3.4, and "*Psychophysical disorders*" was in line with the general average value (3.3).

TABLE 7 Demographic characteristics and the stress perception dimension.

| | Stress perception dimension | | | | |
|---|---|---|---|---|---|
| | <3.3 | | ≥3.3 | | Chi-square test |
| | *n.* | % | *n.* | % | *p* |
| **Sex** | | | | | |
| Male (n. 74) | 68 | 92 | 6 | 8 | 0.986 |
| Female (n. 112) | 103 | 92 | 9 | 8 | |
| **Age (years)** | | | | | |
| <24 (n. 30) | 26 | 87 | 4 | 13 | 0.812 |
| 25–34 (n. 67) | 62 | 92 | 5 | 8 | |
| 35–44 (n. 33) | 31 | 94 | 2 | 6 | |
| 45–54 (n. 34) | 32 | 94 | 2 | 6 | |
| >55 (n. 22) | 20 | 91 | 2 | 9 | |
| **Marital Status** | | | | | |
| Single (n. 96) | 88 | 92 | 8 | 8 | 0.805 |
| Married (n. 78) | 72 | 92 | 6 | 8 | |
| Divorced (n. 10) | 10 | 100 | 0 | 0 | |
| Widowed (n. 1) | 1 | 100 | 0 | 0 | |
| **Contract type** | | | | | |
| Temporary (n. 127) | 114 | 90 | 13 | 10 | 0.111 |
| Permanent (n. 59) | 57 | 97 | 2 | 3 | |
| **Working time regime** | | | | | |
| Part-time (n. 9) | 7 | 78 | 2 | 13 | 0.11 |
| Full-time (n. 177)0 | 164 | 93 | 13 | 7 | |
| **Position Director** | | | | | |
| Yes (n. 50) 0 | 45 | 90 | 5 | 10 | 0.557 |
| No (n. 136) | 126 | 93 | 10 | 7 | |
| **Working Seniority (years)** | | | | | |
| <1 (n. 27) | 20 | 74 | 7 | 26 | 0.011 |
| 1–4 (n. 55) | 52 | 94 | 3 | 5 | |
| 5–9 (n. 28) | 27 | 96 | 1 | 4 | |
| 10–14 (n. 10) | 8 | 80 | 2 | 20 | |
| 15–20 (n. 25) | 24 | 96 | 1 | 4 | |
| >20 (n. 27) | 26 | 96 | 1 | 4 | |

TABLE 8 Organizational fairness.

| | Average value ± standard deviation (SD) |
|---|---|
| Career opportunities for everyone | 3.1 ± 0.94 |
| Appreciation of commitment/initiatives | 3.4 ± 0.75 |
| Opportunities for improvement | 3.1 ± 0.95 |

Regarding positive indicators, "*Sense of belonging to a team*," "*Desire to work*" and "*Excellent work relationship*" were the most expressed indicators in the study population. Regarding negative indicators, gossip was the most frequently cited factor

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TABLE 9 Demographic characteristics and the organizational fairness dimension.

| | Organizational fairness dimension | | | | |
|---|---|---|---|---|---|
| | <3.3 | | ≥3.3 | | Chi-square test |
| | *n.* | % | *n.* | % | *p* |
| **Sex** | | | | | |
| Male (n. 74) | 68 | 92 | 6 | 8 | 0.986 |
| Female (n. 112) | 103 | 92 | 9 | 8 | |
| **Age (years)** | | | | | |
| <24 (n. 30) | 26 | 87 | 4 | 13 | 0.812 |
| 25–34 (n. 67) | 62 | 92 | 5 | 8 | |
| 35–44 (n. 33) | 31 | 94 | 2 | 6 | |
| 45–54 (n. 34) | 32 | 94 | 2 | 6 | |
| >55 (n. 22) | 20 | 91 | 2 | 9 | |
| **Marital Status** | | | | | |
| Single (n. 96) | 88 | 92 | 8 | 8 | 0.805 |
| Married (n. 78) | 72 | 92 | 6 | 8 | |
| Divorced (n. 10) | 10 | 100 | 0 | 0 | |
| Widowed (n. 1) | 1 | 100 | 0 | 0 | |
| **Contract type** | | | | | |
| Temporary (n. 127) | 114 | 90 | 13 | 10 | 0.111 |
| Permanent (n. 59) | 57 | 97 | 2 | 3 | |
| **Working time regime** | | | | | |
| Part-time (n. 9) | 7 | 78 | 2 | 22 | 0.11 |
| Full-time (n. 177)0 | 164 | 93 | 13 | 7 | |
| **Position Director** | | | | | |
| Yes (n. 50) 0 | 45 | 90 | 5 | 10 | 0.557 |
| No (n. 136) | 126 | 93 | 10 | 7 | |
| **Working Seniority (years)** | | | | | |
| <1 (n. 27) | 20 | 74 | 7 | 26 | 0.011 |
| 1–4 (n. 55) | 52 | 94 | 3 | 6 | |
| 5–9 (n. 28) | 27 | 96 | 1 | 4 | |
| 10–14 (n. 10) | 8 | 80 | 2 | 20 | |
| 15–20 (n. 25) | 24 | 96 | 1 | 4 | |
| >20 (n. 27) | 26 | 96 | 1 | 4 | |

by workers, with a mean value of 3.0, which was slightly below the general average (Table 13).

Workers perceived the working environment as open to innovation (especially regarding the introduction of new technologies and the optimization of working procedures, which results in coping with problems better) and safe.

Regarding managers, workers appreciated coherent management behaviors, their interest in work problems and their ability to treat workers fairly.

Conflict situations in the workplace were poorly perceived. In fact, approximately 79% of the workers declared the absence of psychological violence, and 127 subjects (65.4%) confirmed the absence of marginalization.

TABLE 10 Collaboration between colleagues.

| | Average value ± standard deviation (SD) |
|---|---|
| Availability to meet the needs of the organization | 3.85 ± 0.36 |
| Collaboration between colleagues | 3.83 ± 0.43 |
| Willingness to share information | 3.63 ± 0.60 |
| Efforts to achieve results | 3.66 ± 0.55 |
| Availability to meet the needs of colleagues | 3.76 ± 0.50 |
| Communications between the working group | 3.43 ± 0.70 |
| Appropriate solutions to problems | 3.66 ± 0.57 |

TABLE 11 Organizational efficiency.

| | Average value ± standard deviation (SD) |
|---|---|
| Clear and defined objectives | 3.65 ± 0.62 |
| Presence of tools/resources to better cope with the job | 3.77 ± 0.50 |
| Easily obtainable information | 3.65 ± 0.58 |
| Problem solving | 3.64 ± 0.58 |
| Satisfaction after the day's work | 3.73 ± 0.52 |
| Development of professional/individual qualities | 3.53 ± 0.66 |
| Opportunity to ask for information | 3.62 ± 0.64 |
| Satisfaction with health company initiatives | 3.59 ± 0.64 |
| Clear and well-defined work tasks | 3.63 ± 0.62 |
| Utility of services provided | 3.47 ± 0.80 |

TABLE 12 Room comfort.

| | Average value ± standard deviation (SD) |
|---|---|
| Cleanliness | 3.80 ± 0.49 |
| Light | 3.63 ± 0.65 |
| Temperature | 3.42 ± 0.73 |
| Silence | 3.23 ± 0.92 |
| Building condition | 3.65 ± 0.64 |
| Pleasant rooms and furnishings | 3.60 ± 0.64 |
| Available space per worker | 3.53 ± 0.74 |
| Sanitary facilities | 3.73± 0.55 |

Psychophysical disorders were found to be scarcely present, except for asthenia, which was often reported by 31.4% of the workers.

Finally, regarding the absences from work, we found that in the last 3 months, 84.6% of the health workers had not been absent for health reasons.

TABLE 13 Satisfaction (positive and negative indicators).

| Positive indicators | Average value ± standard deviation (SD) | Negative indicators* | Average value ± standard deviation (SD) |
|---|---|---|---|
| Satisfaction with the organization | 3.55 ± 0.67 | Intolerance | 3.3 ± 0.89 |
| Desire to engage | 3.67 ± 0.58 | Disinterest | 3.4 ± 0.80 |
| Sense of belonging to a team | 3.78 ± 0.56 | Desire to change | 3.3 ± 0.90 |
| Desire to work | 3.71 ± 0.56 | Gossip | 3.0 ± 0.99 |
| Personal fulfillment | 3.65 ± 0.61 | Resentment | 3.2 ± 0.95 |
| Faith in change | 3.41 ± 0.81 | Aggressiveness/nervousness | 3.3 ± 0.90 |
| Work/life balance | 3.39 ± 0.82 | Feeling of doing useless things | 3.5 ± 0.78 |
| Excellent work relationships | 3.70 ± 0.63 | Feeling of being unimportant | 3.1 ± 1.0 |
| Sharing of work activities | 3.64 ± 0.66 | Feeling of being underestimated | 3.1 ± 1.0 |
| Faith in the leadership | 3.52 ± 0.75 | Inefficiency in performing tasks | 3.4 ± 0.82 |
| Faith in the morality of the leadership | 3.54 ± 0.73 | Dubious attribution of tasks | 3.3 ± 0.9 |
| Appreciate the job | 3.46 ± 0.81 | Absence of initiative | 3.4 ± 0.86 |

*For this indicator, it was necessary to reverse the method of scoring to standardize the reading of the result.

## Discussion and conclusion

The present study investigated the strong points, criticality, and perceptions of organizational wellbeing of 188 health professionals engaged in the management of the current health emergency in the recently developed Italian COVID-19 hospital in the city of Bari, highlighting the relationship between the characteristics of the work context and psychophysical wellbeing of health care workers.

In health care companies, organizational success is achieved through several factors related to the human, relational and structural aspects of the organization. Health professionals, through their expertise, must provide quality care to patients. This aspect, combined with the psychophysical wellbeing of workers, affects the effectiveness of the provision of health services (2).

Stress and dissatisfaction at work are widespread conditions in health care personnel (18). In fact, various studies have confirmed that high stress levels in health care staff are connected to lower job performance and higher absenteeism. Conversely, several studies have evaluated the conditions promoting wellbeing, motivation, and job satisfaction (19), such as clear organizational objectives, good relationships with leadership, and adequate pay and working conditions (20, 21).

The health emergency related to the spread of the COVID-19 pandemic has led to a progressive increase in the complexity of work in the health care sector, complicating relationships with people and the ability to respond to user requests and resulting in an increased assumption of direct responsibility for work. Several studies have confirmed that during the pandemic, due to hard work in very challenging conditions, health care staff members were overworked, resulting in excessive physical and psychological efforts (22, 23).

In our study, the General Profile analysis (mean value 3.3) showed a positive level of organizational wellbeing, according to the interpretative parameters indicated by the authors of the MOHQ questionnaire (Table 3). Analyzing the 12 dimensions of organizational wellbeing in detail, only three dimensions were found to be below the average calculated for the general profile, and only two of these dimensions were found to be negative with respect to the authors' interpretation criteria (Table 3).

The first critical area expressed by the sample is the so-called "Job demands" dimension. The health care workers described their jobs as intense due to the fatigue of managing daily relationships with other people, the resulting excessive sense of mental strain, the anxiety connected to direct responsibility for work, and the general sensation of feeling overworked. This dimension is the picture of a highly involved job in the cognitive and emotional spheres. Regarding the relationship between demographic characteristics and the job demand dimension, the analysis of the tested demographic variables (age, sex, contract type, working time regime, position director status and working seniority) did not show significant differences, except for marital status. In fact, the "single" workers suffered more from the burden of job demands ($p < 0.038$). This result is in line with a previous Iranian cross-sectional study that observed a negative correlation between marital status and job strain in critical care nurses (24). This result may be explained by the possibility of sharing work problems with a partner and receiving emotional support.

The mean scores analysis of the single items of "*Stress perception*" confirmed the intensity of the work as the main critical area: health workers described their job duties as stressful and exhausting. It follows that the work is often perceived as all-encompassing, as stated by 40% of the subjects. The statistical analysis highlighted a lower stress perception and a

perception of better organizational fairness in subjects with less working seniority ($p < 0.011$). Research from the University of Nottingham showed how work-related stress tends to increase with age, peaking between the ages of 50 and 55 years. In fact, older workers have greater difficulties adapting to change, partly due to health problems and family responsibilities (25).

However, regarding the direct question being useful in quantifying the burden resulting from the characteristics of their work, 77.7% of the employees reported that overworking did not cause difficulties.

Regarding the third critical dimension ("*Organizational fairness*"), the three assessment factors ("*Career opportunities for everyone*," "*Appreciation of commitment/initiatives*," "*Opportunities of improvement*") had no significant deviation from the mean value of the "General profile."

Therefore, these factors assess subjective perceptions of slight discomfort. In addition, the evaluation of the "*Appreciation of commitment/initiatives*" factor showed that more than half (57%) of the workers considered their commitment to work and personal initiatives was fully appreciated. Furthermore, the evaluation of the "*Organizational Efficiency*" dimension showed excellent results. In particular, the "*Development of professional/individual qualities*" factor had an average score of 3.53, and 76.1% of the workers said they felt fully satisfied at the end of the working day. As further confirmation, the "*Openness to innovation*" dimension highlighted the ability of the organization to enhance the development of new skills in workers, as well as the willingness to introduce new professional figures to staff.

The dimensions that evaluated interactions with colleagues had the highest score (3.7). Eighty-five percent of the workers confirmed an optimal collaboration with colleagues (3.83±0.43), which was perceived as a source of work support and affective support. In the same way, management support was favorable (3.5), mainly due to the involvement shown by the managers toward the problems of the staff, their consistent behaviors and their fair treatment of workers. Approximately 66.5% of the participants reported the absence of conflicts with their superiors. To confirm how positive human interactions at all levels in the working environment are beneficial to the psychophysical health of workers, an analysis of positive indicators revealed the workers' perceptions of excellent working relationships, the sense of belonging to the team, the desire to go to work, personal satisfaction, and the sharing of work activities. The scientific and medical literature shows consistent findings about the importance of positive relationships between colleagues in the workplace. Tran et al., in a survey of 303 hospital nurses, demonstrated a lower level of job stress and higher commitment in a working environment characterized by good relationships between colleagues; in addition, the results of this study showed that high-quality relationships between leaders and their staff improved job performance (26). The importance of a positive working environment was confirmed by a recent study in which Rasool et al. suggested that a toxic work environment had a negative impact on employee engagement, spreading negative feelings among colleagues. Feelings arising from a toxic work environment (e.g., harassment, bullying or ostracism) can lead to excessive stress, burnout and anxiety among workers. The same authors showed that when workers perceived support from the organization, they increased their engagement and their sense of belonging to the organization was enhanced (27).

In our study, the job satisfaction expressed by the participants was confirmed by the good results obtained in the evaluation of negative indicators and psychophysical disorders manifested in the last 3 months. In a recent review about the impact of COVID-19 on the mental health of health care workers, De Kock et al. highlighted that high levels of stress and anxiety have been shown to decrease staff morale, increase absenteeism, and cause lower levels of work satisfaction and quality of care (28).

In our sample, asthenia, sleep disturbance and anxiety were the most frequent problems, affecting only 6.9, 11.2, and 6.9% of the sample, respectively. This state of wellbeing was confirmed by the data about absences from work: in the last 3 months, 84.6% of the health workers had not been absent for health reasons.

Regarding the characteristics of the working environment, it has long been known that the physical environment of a health care facility can affect patients and staff. In a review of the physical characteristics of the indoor environment in health care facilities, the authors suggested that the acoustic environment, ventilation system, air conditioning system, thermal environment, visual environment (e.g., lighting and views of nature), ergonomic conditions and furniture have beneficial effects for the wellbeing of patients and staff (29). In our study, the "*Room comfort*" dimension had a mean score of 3.6, followed by the "*Job security*" dimension (3.5). Most of the sample (81.4%) had a very positive view of the cleanliness of the working environment, the condition of the building (71.3%) and the lighting (70.7%). A total of 86.7% of the participants perceived a high involvement of the organization in health and safety in the workplace.

The assessment of organizational wellbeing allowed us to obtain an overall picture of the working atmosphere and to indicate important strategies to improve it and the services provided.

On the basis of the useful suggestions provided by the interviewed staff to improve organizational wellbeing, the first intervention to be put in place is the valorisation of the staff (47.3%), followed by the identification of an

incentive distribution system that can reward staff for the work performed (31.9%).

Our study had certain limitations. First, the questionnaire used did not allow us to stratify the result according to the professional category of health care workers. Second, the assessment of individual psychological characteristics is lacking, although it is an important element in fully characterizing wellbeing in the workplace. It would therefore be advisable for future studies to focus on this aspect. Despite these limitations, these results could help to define and structure paths for change and training activities for workers to improve the work context. In particular, from the analysis of the identified criticalities and from the considerations of the workers, various operating strategies were derived:

- Enhancement of personnel and meritocracy, allowing operators to carry out an activity for which they have been trained, in which their performance is the best possible and the incentives are proportionate to the results achieved.
- Evaluation sheets to redistribute assignments by skills.
- "Internal working model" seminars through which a worker can face and solve stressful events.
- Improvement of procedures to facilitate the performance of demanding activities.
- Early detection and intervention of risk situations (i.e., stress, burnout).
- Training activities.
- Focus groups for sharing critical issues connected to emotional experiences that are related to work.
- Optimizing work and life balance, managing working time in a more flexible way, aiming at the result and not at the number of working hours.

Our results show the effectiveness of the organizational model adopted in the management of the COVID-19 hospital in Bari, especially in view of the work and emotional overload of the personnel called to face the epidemiological emergency on the frontline, which, however, did not adversely affect the psychophysical conditions of the workers.

The success of this model is related to the coexistence of all levels of care (medical, surgical, services) required during any type of health emergency in a single structure. Moreover, the importance of paying particular attention to the architectural, functional, and procedural aspects of health care and to the so-called "humanization" of care has been realized. All these factors show that the place where therapies are carried out can influence outcomes, helping to improve the job performance of health workers and the psychophysical conditions of patients.

## Data availability statement

The data presented in this study are available on request from the corresponding author.

## Ethics statement

Ethical approval was not provided for this study on human participants because Ethical Approval is not necessary because all the medical and instrumental examinations were performed according to the Italian laws concerning the protection of workers exposed to occupational risks (D. Lgs. 81/2008). The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects/patients have been approved by the Occupational Medicine Unit, which deals with the health surveillance of all health care workers in the hospital, in accordance with the Italian legislation on the protection of workers exposed to occupational risks (Legislative Decree n.81/2008). The patients/participants provided their written informed consent to participate in this study.

## Author contributions

LV, GMig, AD, AM, and GMil conceived and designed the study. LD, EC, SS, AC, and LS were responsible for the acquisition and analysis of the data. AP performed the statistical analyses. LD, EC, SS, and AC wrote the paper. All authors approved the final version.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note

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EDITED BY
Alejandro Vega-Muñoz,
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REVIEWED BY
Naeem Hayat,
Kota Bahru, Malaysia
Joseph Odhiambo Onyango,
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Suchismita Satapathy,
KIIT University, India

*CORRESPONDENCE
Lilis Surienty
lilis@usm.my
Md. Mahmudul Haque
mahmudul.haque@ums.edu.my

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# Impact of organization decision making styles and safety accountability on occupational health and safety implementation: The moderating role of mimetic motives

Muhammad Aamir Nadeem[1], Lilis Surienty[1]* and Md. Mahmudul Haque[2]*

[1]School of Management, Universiti Sains Malaysia, Penang, Malaysia, [2]Labuan Faculty of International Finance, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia

The agriculture sector is a traditional economic pillar of many emerging economies. However, it is facing greater occupational health and safety (OHS) challenges in Pakistan, and its performance is continuously decreasing. An effective OHS implementation provides better control over OHS challenges and may help to restore its former glory. Therefore, this study aims to explore different organizational decision-making styles and safety accountability to put OHS into practice in this sector. Based on institutional theory, a theoretical framework was developed. Two hundred and eighty-seven agriculture farms in Punjab, Pakistan were surveyed and analyzed using SmartPLS 3.3.7. The findings revealed that implementation styles (rational and incremental) and safety accountability positively impact OHS implementation. Similarly, the moderating role of mimetic motives was found positively significant in the relationship between rational style and OHS implementation, and negatively significant in the relationship between incremental style and OHS implementation. While no moderating effect of mimetic motive was found between safety accountability and OHS implementation. This study suggested that OHS implementation should not be viewed as a social or technical issue alone. Strategic arrangements should be made at the organizational level to gain better control over OHS challenges by considering the institutional environment in which the organization operates.

KEYWORDS

**occupational health and safety implementation, safety accountability, organizational decision-making styles, agriculture, mimetic motives**

## Introduction

The OHS implementation at the organizational level in the 21st century has long been a cause of concern. According to International Labor Organization (ILO), OHS means the science of anticipation, recognition, evaluation, and control of hazards arising in or from the workplace that could impair the health and well-being of workers, considering the possible impact on the surrounding communities and general environment (1). Based on the definition, it is the prime responsibility of any organization to provide a safe working environment and consider the health and well-being of all stakeholders. In the OHS domain, work-related diseases and injuries are the major occupational health problem (2, 3). The report by Workplace Safety and Health Institute of 2017 revealed that approx. 2.78 million deaths occur annually across the world (2). It further highlighted that 86.3% of the total deaths were attributed to occupational diseases and 13.7% to fatal accidents. Based on ILO (4) assessments, more than 2.3 million workers die each year from work-related diseases and injuries, 160 million suffer from non-fatal work-related diseases, and 313 million from non-fatal injuries. Therefore, concerns about OHS are widespread across both industrial and emerging economies (5, 6). For instance, in Great Britain, 123 workers died per 1,000 in work-related accidents in 2021-22 (7). Additionally, the report found that construction and agriculture have the highest rates of work-related accidents. Similarly, more than 1,700 work-related accidents were reported until March 2022 in Malaysia, while agriculture was the second most affected sector after manufacturing (8). In Pakistan, agriculture is a prominent sector for worker-related injuries and deaths. This sector accounted for 29.25% of workers' deaths in 2020-21 (9). Consequently, work-related injuries and deaths implicate an imminent cost on the socioeconomic systems, destabilizes the worker earning capacity, and adversely affect the nation's productivity level (10). According to the recent estimates of ILO (4), more than 4% of the world GDP per year is lost as a result of work-related diseases and injuries which rises to 6% in emerging economies.

In recent decades, the OHS domain has gained popularity both in the industrial and scholarly world. The OHS implementation has directly supported the Sustainable Development Goals (SDGs), like SDGs 3.9, 8.8, and 16.6 (11). Ivascu et al. (12) argued that OHS facilitates organizations to achieve sustainability and innovation performance. Fonseca and Carvalho (13) stated that organizations having OHS certification performed better to achieve sustainable development goals. Additionally, Zorzenon et al. (14) posited that OHS and digital technologies help to promote SDGs. Ávila-Gutiérrez et al. (15) claimed that OHS must be aligned with current industry norms to achieve the SDGs and smooth transition from Industry 4.0 to 5.0.

A considerable number of study has been published on occupational health and safety. These studies are more focused on oil and gas (16), transportation (17), manufacturing (18), and mining (19). However, agriculture is the most neglected sector in terms of OHS implementation. For example, there is a lack of empirical evidence in agriculture, especially in agro-based economies like Pakistan. Although few researchers attempted to perform empirical research in agriculture or related sectors in Pakistan (10, 20, 21). However, the prior studies contextualized OHS as a human indicator like gender (21) and occupations (16). Noman et al. (10) argued that organizational and human perspectives must be examined separately to understand the OHS setups in developing countries better. Based on organizational context, a decision strategy is considered a vital factor in promoting OHS implementation. Andrews et al. (22) argued that organizational decision-making styles (rational & incremental) are vital to achieving OHS implementation. Likewise, Otok et al. (23) claimed that organizational decision-making styles help to mitigate disaster risk in developing countries. Additionally, in the era of COVID-19, safety accountability is a prominent enabling factor for OHS implementation at the organizational level (24). Although the OHS research domain has gained significant attention, several lines of inquiry need urgent action, like organizational strategic decision-making style (22, 23), and safety accountability (24). Additionally, Ju et al. (25) claimed that some external stimuli or motives influence a firm's strategic actions to promote OHS implementation. Generally, these motives are known as mimetic motives. Taylor and Buumba (26) argued that mimetic motives affect the OHS implementation practices in the service sector. They further argued that more research is required in other sectors of the economy.

Despite being a vital and integral aspect of organizational objectives, OHS implementation has rarely been studied. Notably, there is a lack of research that elucidates OHS implementation in the agricultural sector. Therefore, the present study aspires to investigate the impact of different organizational decision-making styles, safety accountability, and mimetic motives in OHS implementation by raising the research question that "how different types of organizational strategies impact OHS implementation?". To address the research question, this study will be able (a) to evaluate the impact of organizational decision-making styles & safety accountability on OHS implementation and (b) to examine the moderating effect of mimetic motives on decision-making styles and OHS implementation. A number of contributions and implications will result from this effort once the research objectives have been achieved. For example, this study will enhance the theoretical understanding of institutional theory from an OHS implementation standpoint. Similarly, it will help managers to design OHS implementation programs, especially in the agriculture sector. Furthermore, the research findings may help national authorities to formulate policies regarding training and technology selection for OHS implementation. Most importantly, this study will provide the liberty to

agriculture organizations to choose implementation style for OHS implementation as per their competencies, environmental uncertainties, and their desire to be like other organizations.

The following section presents the theoretical framework and hypothesis development. After that, material and methods, results and discussion of the findings are presented. Finally, the conclusion, limitations, and future research avenues are discussed.

# Theoretical foundation and hypotheses development

## Institutional theory and OHS implementation

Institutional theory refers to managing an organization's environment. Phillip Selznick initially defined its fundamental concept in the year 1949. Subsequently, John Meyer and Brian Rowan, as well as Paul J. DiMaggio and Walter W. Powell advanced it in 1977 and 1983, respectively (27). This theory not only explains how certain institutions influence the organization's behavior and decision-making process in which it operates but also why organizational structures and practices change (28, 29). Six key concepts make the basis of this theory: legitimacy, isomorphism, rational myths, loose coupling, diffusion, and the infusion of value (27). Collectively, these concepts ensure the survival of an organization in the institutional environment with both technical (i.e., capital and labor) and social (i.e., legitimacy and status) perspectives. Therefore, legitimacy and isomorphism are considered central assumptions of this theory.

As an essential organizational component, OHS implementation is seen as a social and technical aspect of managing an organization's environment. It reflects how an organization promotes health and safety at the workplace, which impacts several dimensions of performance, such as productivity, absenteeism, and employee satisfaction (30). Jilcha et al. (31) stated that implementation of the OHS requirements is not the only responsibility of internal stakeholders, but external stakeholders such as governing bodies, unions, insurance agencies, and other higher institutions are also equally responsible. For this reason, the institutional theory could result in better OHS implementation due to the effective involvement of both internal and external stakeholders.

Furthermore, various past research work [e.g., (32–38)] in occupational health and safety have employed this theoretical ground to understand the organizational behavior in responding to the OHS issues. The other strength of this theory is that it supports organizational transformation, even if the technical or economic advantages are lacking (39, 40). Therefore, this is also the reason that the present study employs the institutional theory to explain the influence of different institutions (i.e., factors) on OHS implementation.

## Implementation style and OHS implementation

Implementation style is a process of putting a plan into practice. Pollitt and Bouckaert (41) emphasized that understanding the implementation dynamics of a program requires an awareness of implementation styles. Similarly, Andrews et al. (22) stated that the successful execution of a plan or program depends on a particular implementation style, which, as a result, has substantial significance for the performance of an organization. Several styles of implementation exist in the literature. However, researchers explicit them into two main categories: rational style and incremental style (22, 42). The rational style is a systematic and well-planned approach that prioritizes organizational changes and gets people to follow the precise procedure to adopt these changes. Whereas incremental style is a fluid nature style of organizational change which encourages modification step by step based on the ground realities (22). Past studies revealed mixed findings on implementation styles. For example, Andrews et al. (43) used these implementation styles to check service performance in public organizations. The study revealed that no implementation style by itself is effective, but that style is contingent on organizational strategic orientation. Similarly, Andrews et al. (22) studied the individual and combined effect of rational and incremental implementation styles in public sector organizations in Turkey. It found that the organization performs better that use a combined implementation style more than those that emphasize a single style. Whereas the absence of a style may lead to worse performance. On the contrary, Balogun and Jenkins (44) explain that the rational style gives better results in reactive situations or crises. In contrast, the incremental style best suits managers to adopt in proactive situations. As the OHS program not only provides controls in proactive ways but also enables organizations to handle hazardous situations by remedial measures. Therefore, analyzing both implementation styles is important to assess which style leads to better OHS implementation. Thus, the following hypotheses are proposed:

H1: The rational style has a significant positive impact on OHS implementation but is greater than the incremental style.

H2: The incremental style has a significant positive impact on OHS implementation but less than the rational style.

## Safety accountability and OHS implementation

Safety accountability is essential for OHS implementation. It creates and establishes in each employee a sense of obligation to perform assigned tasks effectively and efficiently. For example,

management is responsible to design policies and procedures, clarify roles and responsibilities, provide appropriate training and infrastructure, and granting employees sufficient authority to do their part in OHS implementation well (45). Similarly, it is the responsibility of safety personnel to encourage management and all other employees to OHS implementation. It is because OHS implementation is an organization-wide effort. The safety department or safety personnel cannot ensure its success on their own alone. Therefore, everyone in the organization is responsible for its success (46). However, without safety accountability, a safety program implementation is likely to be unsuccessful or only ceremonial. Kim et al. (46) argued that an organization cannot achieve safety excellence until its management and all other employees are not accountable for their measurable responsibilities. Moreover, Mlynek (47) stated that safety accountability is not a punitive strategy but rather a proactive means of fostering a culture of responsibility. As such, the following hypothesis was developed:

H3: Safety accountability has a significant positive impact on OHS implementation.

## Moderating role of mimetic motives and OHS implementation

Mimetic motives refer to the extent to which an organization implements a program by mimicking the best practices of leading organizations in an attempt to gain legitimacy. This trend is most common in developing countries because it saves both cost and time (48). Moreover, Ansari et al. (49) argued that mimicking behavior consist of two perspectives; laws & regulations, and societal norms & values. The first perspective stems at to achieve legitimacy, which is vital in securing resources for continued existence over the long run (29). Whereas the second perspective is of moral origin, which emboldens ethical and responsible behavior regardless of the outcomes (28, 50).

McBain-Rigg et al. (51) identified peer-to-peer networking, industry representatives, government, and media as the most influential agents for safety implementation in the agriculture and fishery sector of Australia. Similarly, Iatridis et al. (52) found that governmental authorities, NGOs, and the local community are mimetic motives that influence them to commit fully to certify management standards, such as OHSAS 18001. Another perspective proposed by DiMaggio and Powell (39), is that mimetic motives are especially relevant in those organizations where technology is poorly understood, the environment is uncertain, and goals are ambiguous. Thus, based on institutional theory, this study understands mimetic motives as institutional motives that push organizations to adopt OHS implementation as strategy implementation. Furthermore, this study expects that the organizations that have a strong influence from mimetic motives, their decision-making styles for implementation, and safety accountability would be high for OHS implementation. This indicates moderating effects of mimetic motives on the relationships between exogenous and endogenous variables. Therefore, it is necessary to explore the role of mimetic motives in implementing the OHS. Thus, the following hypotheses were developed.

H4: Mimetic motives significantly moderate the relationship between rational style and OHS implementation.

H5: Mimetic motives significantly moderate the relationship between incremental style and OHS implementation.

H6: Mimetic motives significantly moderate the relationship between safety accountability and OHS implementation.

# Materials and methods

## Study area and population

This study focused on the province of Punjab (31.1704° N, 72.7097° E). It is most prominent in agriculture production and has the most significant share in the national economy compared to other provinces. Therefore, the targeted population was all agricultural farms in this province. The latest provincial government statistical record showed that there are 5,249,800 agriculture farms in the whole province (53). Although all districts in the province of Punjab are notable for different varieties of agricultural products. However, the district Bahawalnagar, Bahawalpur, Bhakkar, Sargodha, Multan, Pakpattan, Okara, Jhang, and Layyah were chosen purposively as the study area because these districts contain large farms, and it is assumed that large agriculture farms have dedicated safety personnel and resources to cope with OHS issues.

## Unit of analysis

The agriculture farm was chosen as the unit of analysis because this study is aimed at providing a holistic view of OHS implementation in the agriculture sector of Pakistan. Moreover, the respondents of this study participants were safety person-in-charge (i.e., owners, OHS managers, OHS officers, or OHS representatives). These individuals were selected as respondents for three main reasons. First, they are linked with all activities of other departments and speak for OHS at the executive level. Second, they have sufficient practical and professional knowledge to implement the latest OHS programs. Third, these

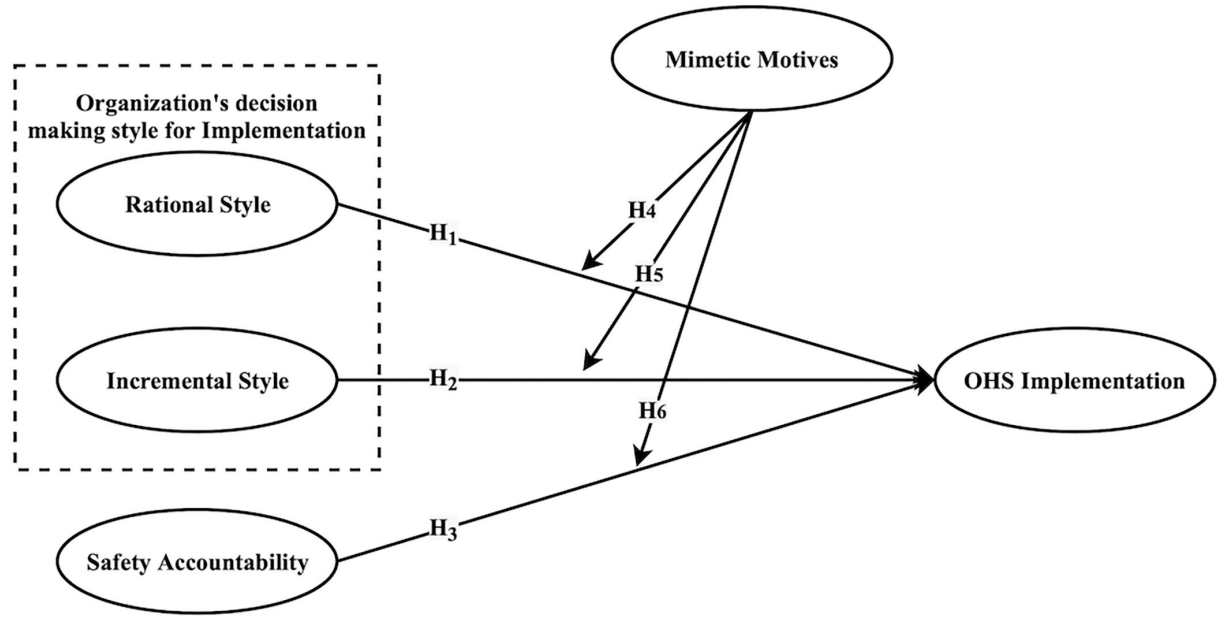


FIGURE 1
Research framework.

people provide reliable information due to their key role in OHS implementation and continuous monitoring.

## Sample size and sampling technique

The G*Power software of version 3.1 was used to calculate the minimum sample size, as recommended by Joseph et al. (54) and Memon et al. (55). A sample size of 153 was calculated with the settings of statistical power of 95%, probability error of 5%, and with a medium effect size of 0.15 for four predictors and three interaction terms. The agricultural farms were selected through purposive sampling. This technique was applied because a comprehensive and up-to-date list of agriculture farms was not readily available. Kumar (56) described that the purposive sampling technique is more suitable, where a complete list of the total population is unavailable to researchers.

## Measures and data collection producer

The questionnaire was divided into two sections. The first section contains the demographics of the respondents, such as gender, age, qualification, designation, working experience, nature of business, farm type, and number of employees. Whereas the second section includes the measures of study constructs. The measures of both rational style (5-items) and incremental style (5-items) were adapted from Andrews et al. (22). The items of safety accountability were adapted from Molenaar et al. (57), which contains four items in total. Similarly, the three items for measuring mimetic motives were adapted from Hillebrand et al. (58). Finally, the intention for OHS implementation was measured with four items adapted from Hossain et al. (59). Moreover, the data of the second section was collected on a 7-point Likert scale from 1 ("strongly disagree") to 7 ("strongly agree"). Keeping the education level of respondents in mind, the questionnaire was translated into Urdu and sent to one academic person and two OHS professionals (i.e., OSH consultants) for content validity. After their feedback, a pre-test with 37 actual respondents was also conducted to confirm the comprehension and reliability of the questionnaire. No major amendments surfaced, aside from a slight change in wording. Moving forward, a paper-based questionnaire was personally handed over to respondents. The questionnaire distribution with this method was aimed at generating a higher response rate (60). A cover letter, stating the confidentiality of data and the nature of the study, was also attached to each questionnaire. A total of 400 farms were targeted through different channels. Moreover, data was collected in a single sitting, specifically from January 2022 to April 2022.

## Data analysis

The PLS-SEM technique was adopted to examine the theory-based conceptual model that is specified in Figure 1. More importantly, this technique provides robustness in analysis and does not rely on data distributional assumptions

(54). Two steps are strictly followed. In the first step, the reliability and validity of constructs were assessed through outer loadings, composite reliability (CR), and average variance extracted (AVE). HTMT was also examined to confirm the establishment of discriminant validity. This is then followed by structural model estimation. This step includes the assessment of the coefficient of determination ($R^2$), path coefficient (β), effect size ($f^2$), predictive relevance ($Q^2$), model fit, and PLS prediction. Furthermore, a bootstrapping procedure with 5,000 iterations was used to test the significance of hypothesized relationships. Besides, moderation was evaluated using an orthogonalization approach (54). Data were analyzed using SmartPLS of version 3.3.7 (61) and SPSS of version 25.

# Results

## Demographics Findings

Most of the participants were men (97.91%) with an age bracket of 31–40 years (47.04%) and had a bachelor's qualification (72.82%). Those who responded as safety in-charge persons (i.e., safety manager, safety officer) accounted for 47.73%, while those who responded as safety representatives or owners were 52.27%. The majority of farms had employees below 50 (79.10%) and livestock nature of business (41.11%). Moreover, private agriculture farms participated in this survey the majority (95.47%). The detailed findings of demographics are illustrated in Table 1.

TABLE 1 Demographic findings.

| Criteria | Description ($n = 287$) | Numbers | Percentage (%) |
|---|---|---|---|
| Gender | Male | 281 | 97.91 |
| | Female | 06 | 2.09 |
| Age (Years) | ≤20 years | 02 | 0.70 |
| | 21 to 30 years | 61 | 21.25 |
| | 31 to 40 years | 135 | 47.04 |
| | 41 to 50 years | 75 | 26.13 |
| | Above 50 years | 14 | 4.88 |
| Respondent's highest qualification | Secondary school certificate | 08 | 2.79 |
| | Bachelor degree | 209 | 72.82 |
| | Diploma | 20 | 6.97 |
| | Postgraduate degree | 50 | 17.42 |
| Current position | Owner | 32 | 11.15 |
| | Safety manager | 23 | 8.01 |
| | Safety officer | 114 | 39.72 |
| | Safety representative | 118 | 41.12 |
| Employee's strength | Below 10 employees | 10 | 3.49 |
| | 11 to 50 employees | 217 | 75.61 |
| | 51 to 100 employees | 48 | 16.72 |
| | Above 100 employees | 12 | 4.18 |
| Business nature | Crops | 37 | 12.89 |
| | Livestock | 118 | 41.11 |
| | Forestry | 22 | 7.67 |
| | Fishery | 24 | 8.36 |
| | Integrated | 86 | 29.97 |
| Type of farm | Public | 13 | 4.53 |
| | Private | 274 | 95.47 |

## Common Method Variance (CMV)

The data on all study constructs were collected in a single sitting and from the same respondent, common method bias could be a potential problem. Three remedies were used to alleviate this problem. First, the participants were informed that there were no wrong or correct answers and that their responses would be anonymous and would not use for their performance evaluation. Additionally, the readability and comprehension of all the items were improved by keeping the question specific and concise by avoiding ambiguous terms (62). Second, Harman's Single Factor test was carried out to check the common method bias in the data. In this approach, all eighteen items were loaded to a single factor using principal component analysis with the varimax rotation method. The single factor explained variance of 28.271%, far below the 50% threshold. Third, a full collinearity test for both endogenous and exogenous variables was applied to examine this problem. The pathological (inner) VIF for all constructs ranged from 1.091 to 1.121, which is less than 3.30 (63), confirming again that CMV is an unlikely threat to this study.

## Measurement model assessment

The framework of the current study contained three exogenous, one endogenous, and one moderating construct. All were proposed as first-order reflective constructs. Therefore, the recommendations of Joseph et al. (54) were followed

TABLE 2 Measurement model: VIF, internal consistency reliability and convergent validity.

| Constructs | Indicator | VIF | Factor loading | Cronbach's alpha | Composite reliability | Average variance extracted (AVE) |
|---|---|---|---|---|---|---|
| Rational style | RS1 | 1.443 | 0.733 | 0.798 | 0.860 | 0.553 |
| | RS2 | 1.516 | 0.736 | | | |
| | RS3 | 1.631 | 0.786 | | | |
| | RS4 | 1.669 | 0.766 | | | |
| | RS5 | 1.464 | 0.692 | | | |
| Incremental style | IS1 | 2.689 | 0.872 | 0.909 | 0.932 | 0.733 |
| | IS2 | 2.543 | 0.860 | | | |
| | IS3 | 2.300 | 0.839 | | | |
| | IS4 | 2.402 | 0.851 | | | |
| | IS5 | 2.459 | 0.858 | | | |
| Safety accountability | SA1 | 1.965 | 0.837 | 0.831 | 0.887 | 0.663 |
| | SA2 | 1.864 | 0.826 | | | |
| | SA3 | 1.682 | 0.800 | | | |
| | SA4 | 1.646 | 0.795 | | | |
| Mimetic motives | MM1 | 1.829 | 0.794 | 0.797 | 0.867 | 0.687 |
| | MM2 | 1.680 | 0.753 | | | |
| | MM3 | 1.630 | 0.929 | | | |
| OHS implementation | OHS1 | 1.917 | 0.837 | 0.867 | 0.909 | 0.715 |
| | OHS2 | 2.491 | 0.869 | | | |
| | OHS3 | 2.388 | 0.862 | | | |
| | OHS4 | 1.842 | 0.813 | | | |

TABLE 3 Measurement model: Discriminant validity ($HTMT_{0.85}$).

| Construct | Mean (SD) | Rational style | Incremental style | Safety accountability | Mimetic motives | OHS implementation |
|---|---|---|---|---|---|---|
| Rational style | 5.617 (1.116) | - | | | | |
| Incremental style | 5.216 (1.382) | 0.278 | - | | | |
| Safety accountability | 5.536 (1.174) | 0.311 | 0.281 | - | | |
| Mimetic motives | 4.148 (1.407) | 0.099 | 0.074 | 0.151 | - | |
| OHS implementation | 6.010 (1.010) | 0.524 | 0.507 | 0.323 | 0.09 | - |

for measurement model assessment. Convergent validity and internal consistency reliability were assessed in the first step, while discernment validity was assessed in the later step. For convergent validity, the factor loading of all items must be higher than 0.703, and the average variance extracted (AVE) should be equal to or higher than the threshold of 0.500 for each scale. Whereas Cronbach's alpha and the composite reliability (CR) of all the reflective constructs must exceed 0.700 to show internal consistency reliability (54). The findings are tabulated in Table 2. It revealed that Cronbach's alpha, CR, and AVE values met the threshold criteria. Similarly, the factor loadings of all indicators, excluding RS5, were also found to be above 0.703. However, RS5 was retained due to three reasons. First, this indicator was vital and of absolute importance for the study. Second, the value of factor loading was very close to the threshold. Third, the AVE value of the relevant construct was meeting the threshold criteria without excluding it. Thus, the constructs of the proposed model were found to have satisfactory convergent validity and internal consistency reliability.

Henseler et al. (64) suggest that the Heterotrait-monotrait (HTMT) ratio of correlation should be tested for discriminant validity. It reflects the distinction of the framework's constructs (63, 64). According to recent literature, the HTMT ratio is more precise and preferred than the Fornell and Larcker criterion and cross-loading method (54). The maximum threshold value of 0.85 indicates sufficient discriminant validity of the constructs (65). The results presented in Table 3 demonstrate that HTMT

TABLE 4 Structural model: Path quality and exploratory power.

| Construct | Path quality of the model | | Exploratory power of the model | | | |
|---|---|---|---|---|---|---|
| | $Q^2$ | Decision | $R^2$ without moderator | Decision | $R^2$ with moderator | Decision |
| OHS Implementation | 0.260 | Medium | 0.333 | Medium | 0.393 | Substantial |

TABLE 5 Structural model: Hypothesized relationship testing and effect size.

| Relationships | β | SD | *t*-values | *p*-values | Decision | $f^2$ statistics | Effect size |
|---|---|---|---|---|---|---|---|
| H1: Rational Style → OHS Implementation | 0.353 | 0.058 | 6.069 | <0.001 | Accept | 0.182 | Medium |
| H2: Incremental Style → OHS Implementation | 0.319 | 0.063 | 5.085 | <0.001 | Accept | 0.150 | Medium |
| H3: Safety Accountability → OHS Implementation | 0.120 | 0.057 | 2.102 | 0.018 | Accept | 0.021 | Weak |
| H4: RS*MM → OHS Implementation | 0.138 | 0.065 | 2.113 | 0.018 | Accept | 0.024 | Weak |
| H5: IS*MM → OHS Implementation | −0.170 | 0.075 | 2.275 | 0.012 | Accept | 0.043 | Weak |
| H6: SA*MM → OHS Implementation | 0.094 | 0.137 | 0.682 | 0.248 | Reject | 0.012 | Weak |

RS, Rational Style; IS, Incremental Style; SA, Safety Accountability; MM, Mimetic Motives; OHS, Occupational Health and Safety; β, Path Coefficient; S.D, Standard Deviation.

< 0.85, meaning that the study's constructs are distinct. Hence, sufficient discriminant validity exists.

Moreover, multicollinearity was also checked through the outer variance inflation factor (VIF) of all items before testing the structural model. Joseph et al. (54) recommend that checking VIF reduces the biasness in the hypothesized relationships. The values of outer VIF ranged from 1.443 to 2.689 (see Table 2), which were far below 3.3 (63), showing no multicollinearity problem in the data.

## Structural model assessment

Following that, the model's path quality, exploratory power model, and strength of the proposed hypotheses were examined in the structural model assessment. The path quality was estimated through PLS blindfolding procedure using the $Q^2$ value. The $Q^2$ value greater than 0 shows a predictive accuracy of the model (65). Additionally, the $Q^2$ value of 0, 0.25, and 0.50 represents small, medium, and large predictive relevance of the path model. Table 4 revealed a $Q^2$ value of 0.260 which means that the model had a medium-size predictive accuracy.

The exploratory power of the model was estimated using coefficients of determination ($R^2$) of the endogenous construct (i.e., OHS implementation). The $R^2$ value tells the total variance explained in the endogenous construct by exogenous constructs (66). The $R^2$ value for OHS implementation indicated a medium exploratory power without a moderator and substantial with a moderator (see Table 4). It means that mimetic motives as a moderator increase the 6% exploratory power of OHS implementation, which is accounted for by the organization's decision-making style for implementation (i.e., rational and incremental) and safety accountability. Next, the strength and statistical significance of the proposed hypothesized relationships were tested. For this purpose, *t*-statistics and path coefficients (β) were evaluated using a bootstrapping procedure with 5,000 subsamples (63). Table 5 revealed that rational style (H1: $\beta = 0.353$, $t = 6.069$, $p < 0.001$), incremental style (H2: $\beta = 0.319$, $t = 5.085$, $p < 0.001$), and safety accountability (H3: $\beta = 0.120$, $t = 2.102$, $p < 0.05$) are having positive significant impact on OHS implementation. Thus, all three direct hypotheses were supported.

Regarding moderation, the interaction terms were created in SmartPLS and analyzed using an orthogonalization approach. Joseph et al. (54) argued that the orthogonalization approach is an extension of the product indicator approach and gave better results than other approaches (i.e., two-stage, and product indicator). The results tabulated in Table 6 showed that mimetic motives (H4: $\beta = 0.138$, $t = 2.113$, $p < 0.05$) positively influenced the relationship between rational style and OHS implementation. Whereas mimetic motives (H5: $\beta = -0.170$, $t = 2.275$, $p < 0.05$) negatively moderate the relationship between incremental style and OHS implementation. However, contrary to hypothesized relationship, mimetic motives (H6: $\beta = 0.094$, $t = 0.682$, $p > 0.05$) were not found to have a moderating effect on the relationship between safety accountability and OHS implementation in either a positive or negative direction and hence rejected. Thus, two moderating hypotheses were found to be supported, and one was rejected. In addition, moderating effect of mimetic motives was also analyzed using a simple slop test. Figure 2A shows that the interaction effect of mimetic motives is consistent with the prediction of H4. The upward increasing slope showed that rational style and OHS implementation are positive for both low and high mimetic motives. However, OHS implementation is higher when there is a low rational style but for those with low mimetic motives. On the contrary, OHS implementation increased through rational style increased for those agriculture farms with higher mimetic

TABLE 6 Structural model: Pls predict.

| Construct | Indicators | RMSE (PLS-SEM) | RMSE (LM) | Difference | $Q^2$_predict |
|---|---|---|---|---|---|
| OHS implementation | OHS1 | 1.292 | 1.494 | 0.202 | 0.266 |
| | OHS2 | 0.813 | 0.941 | 0.128 | 0.234 |
| | OHS3 | 0.852 | 1.001 | 0.149 | 0.184 |
| | OHS4 | 1.277 | 1.465 | 0.188 | 0.187 |

motives. Similarly, Figure 2B shows that when the involvement of mimetic motives is low, the impact of incremental style is higher on OHS implementation. However, when mimetic motives are high, then the relationship between incremental style and OHS implementation is weakened.

More to this, effect size ($f^2$) was also calculated based on the recommendation of Chin (67). It measures the strength of a specific exogenous construct on an endogenous construct by mean change in the coefficient of determination ($R^2$). Cohen (66) described the threshold of 0.35, 0.15, and 0.02 for substantial, medium, and small effect sizes. The statistics in Table 5 are indicative of small to medium effect size.

Likewise, the goodness of the model was also assessed in this study. A long list of fit indices such as standardized root-mean-square residuals (SRMR), unweighted least square discrepancy (d_ULS), geodesic discrepancy (d_G), Normed Fit Index (NFI), RMSEA, and CFI have been proposed in the literature. However, the standardized root-mean-square residuals (SRMR) index proposed by Hu and Bentler (68) is dominant as an approximate model fit criterion in the PLS-SEM context (69). Hu and Bentler (68) suggested a cut-off value of SRMR $\leq$ 0.08 for a good fit. The SRMR = 0.055 was estimated for this study, well below the threshold, indicating a good fit for the proposed model. It is worth mentioning that the absolute application of any fit measure remains not fully developed, and GoF assessment is unnecessary in general in PLS-SEM (65).

In the end, PLS Predict was used to check the out-of-sample predictive relevance (power) of the model with a default setting of k = 10 (70). As $Q^2_{\text{Predict}} > 0$ and the prediction errors in this study are highly symmetrically distributed, a comparison of RMSE values of PLS-SEM and linear regression model (LM) was held as per the recommendation of Shmueli et al. (70). The results in Table 6 show that all indicators of OHS implementation hold true for PLS-SEM < LM, which confirmed the medium out-of-sample predictive power of the model.

## Discussion

The agriculture sector deals with different occupational accidents, and consequently the need for increased intention of OHS implementation. The farm managers and workers are the ones who put OHS implementation into practice. As the implementation styles and safety accountability influence the OHS implementation, the relationship between the interaction of organizational decision-making styles (rational and incremental), safety accountability, and mimetic motives on OHS implementation were investigated. The findings revealed that mimetic motives, in combination with a rational style, had a positive and significant influence on OHS implementation. The interaction of mimetic motives and incremental style, on the other hand, has a negative but significant effect on OHS implementation. However, there was no substantial influence on OHS implementation when mimetic motives were coupled with safety accountability.

The positive impact of both rational and incremental styles on OHS implementation was supported. This is in line with the findings of Andrews et al. (22) who showed that incremental style is positively associated with a higher level of effectiveness but less than rational style. These findings imply that the agriculture sector may minimize occupational injuries and diseases by implementing the OHS program either in a rational or incremental fashion. However, it is worth mentioning that the rational style for OHS program implementation was sub-optimal to the incremental style in the context of the Pakistani agriculture sector.

Similarly, the interaction effect of mimetic motives with implementation styles (rational and incremental) on OHS implementation was also supported. However, the results were surprising. The interaction of mimetic motives with rational styles increased the impact of OHS implementation, while interaction with incremental style decreased the impact of OHS implementation. Taylor and Buumba (26) argued that a particular style typically depends on unforeseen circumstances, such as leadership vision, organizational climate, priorities, and resource availability. Moreover, it might be possible that current management would take pressure from trendsetters, business media, and their competitors to embrace OHS. Therefore, in the presence of these pressures, rational style along with mimetic motives may give better interactional results and may make it a better choice for OHS implementation. However, it might be concerning because such OHS implementation is usually ceremonial or superficial. On the contrary, Cândido and Santos (71) revealed that

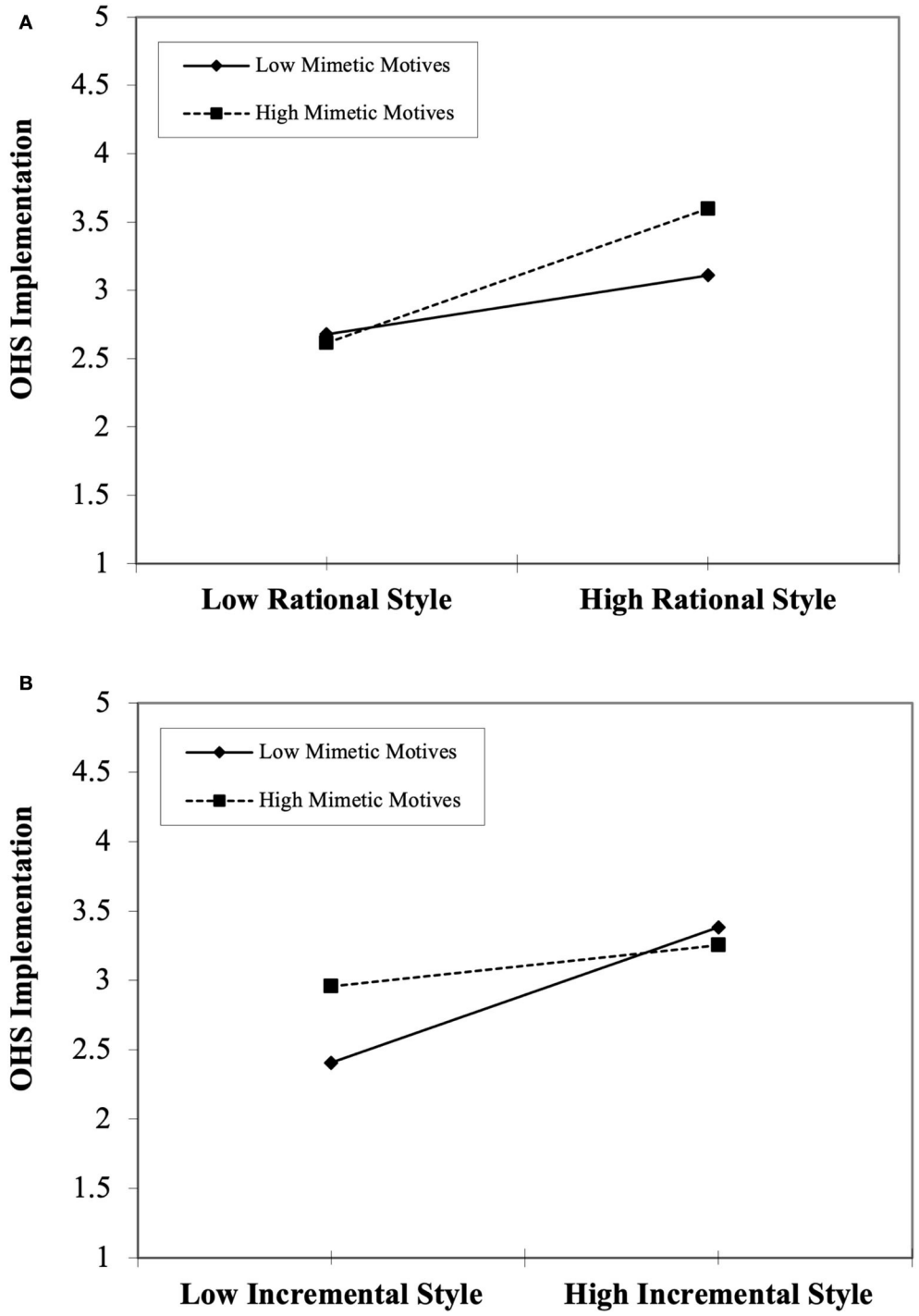


FIGURE 2
**(A)** Interaction of rational style and mimetic motives on OHS implementation. **(B)** Interaction of incremental style and mimetic motives on OHS implementation.

the implementation process requires a longer time for the successful execution of a program. Therefore, a number of factors such as change of leadership, and governance system of regulatory authorities might influence the OHS implementation. Given that implementation style may likely change with the change of management during the implementation phase

of the OHS program or trend-setter's fashion become old or obsolete. Therefore, the interaction of incremental style and mimetic motives might result in a negative trend in OHS implementation.

Furthermore, the result showed a positive and significant impact of safety accountability on OHS implementation. Prior research has also emphasized the need to assign responsibilities to employees (46). Employees who feel empowered take responsibility for their safety (72) and hold themselves accountable (46). As a consequence, there is better OHS implementation, which reduces occupational injuries and diseases. Finally, the interaction effect of safety accountability and mimetic motives on OHS implementation was not supported. A possible explanation for this result is that safety accountability is generally perceived as a punitive practice, while mimetic motives encourage organizations to mimic best practices. Consequently, employees resist imitating such practices. Another possible reason might be the infancy stage of OHS implementation in the agriculture sector of Pakistan. OHS implementation is viewed as the responsibility of the OHS department or safety staff only. Therefore, other departments and employees bear no responsibility for safety.

## Theoretical implications

This study has fourfold theoretical implications. First, it adds to the body of OHS literature by combining organizational decision-making styles, safety accountability, and mimetic motives for OHS implementation through the lens of institutional theory. Second, although the importance of safety management practices for OHS implementation has been proven in past studies, these constructs, to the best of our knowledge, have been brought together into a single model for the first time. Third, the organization's style of implementation and safety accountability are important predictors in achieving OHS implementation. However, this study contributes to the sense that the choice of implementation style depends on the organizational competencies and priorities. Finally, previous research such as Iatridis et al. (52) and Hillebrand et al. (58) have examined the interactive effect of mimetic motives in the context of the certified management system and customer relationship management implementation, respectively. This research has looked at its moderating effect in the field of OHS and has discovered that mimetic motives play a significant role in OHS implementation in the Pakistani agriculture sector.

## Practical implications

Overall, the findings of this study have a number of practical implications for OHS professionals, OHS practitioners, and national authorities for better OHS implementation. First, the findings of this study might enable OHS professionals in designing and developing an OHS implementation program by keeping in mind the organizational competencies and priorities. Second, the findings may help OHS practitioners to execute OHS plans and procedures in accordance with the duties and responsibilities that have been assigned to them. Third, it may enable the national authorities in making better policies and decisions about OHS training, field demonstrations, and technology selection for OHS implementation. Fourth, it may help agriculture organizations to be vigilant about safety-related market developments, especially their competitors' best practices. This could help them to stay in business and gain legitimacy in the long run. Finally, the findings provide the liberty to agriculture organizations to choose an implementation style for OHS implementation as per their competencies, environment uncertainties, and their desire to be like other organizations.

# Conclusion

We conceptualized OHS implementation as a positive gateway toward OHS management that is based on the organization's decision-making styles and safety accountability. By doing so, we hope to help OHS professionals and practitioners advance their knowledge about the complex phenomenon of fear of failure in OHS implementation. Thus, OHS implementation should not be viewed as a social or technical issue alone. Instead, arrangements should be made at the organizational level to gain better control over OHS challenges by considering the organizational factors as well as the institutional environment in which the organization operates and to attain legitimacy for survival.

# Limitations and future directions

This research adds new empirical insights to the growing body of literature studies on OHS implementation in the fields of the agriculture sector. There are, however, three major caveats that could be addressed in future studies. First, safety management practices such as management commitment, safety training, and others were not included. Future studies are welcome to measure the impact of safety management practices on OHS implementation in the presence of mimetic motives. Second, the current study was purely cross-sectional in nature which showed a static picture of the OHS phenomenon. Future researchers are encouraged to apply qualitative methods or perform longitudinal studies to examine the dynamic picture of OHS implementation in the agriculture sector. Last, the overprotectiveness of respondents

was also observed during data collection. Many farm owners and staff were reluctant to fill out the questionnaire for fear of repercussions from the government and regulatory bodies. Therefore, future studies must take some suitable measures to avoid this problem.

## Data availability statement

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

## Author contributions

MN conceptualized, designed, and wrote the original draft. MN and MH did the data analysis, interpretation, and secured funds. LS supervised, critically reviewed, and edited the manuscript. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Michele Carugno,
University of Milan, Italy

REVIEWED BY
Antonio Caputi,
University of Bari Aldo Moro, Italy
Irtyah Merchaoui,
University of Monastir, Tunisia
Dario Consonni,
IRCCS Cà Granda Foundation
Maggiore Policlinico Hospital, Italy

*CORRESPONDENCE
Jianwei Shi
shijianwei_amy@126.com
Jinzhong Zhao
zhaojinzhong@vip.163.com
Lijun Wei
winny@126.com
Xiaojing Huang
jocelyn03@163.com

†These authors share first authorship

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# Risk factors for musculoskeletal disorders among takeaway riders: Up-to-date evidence in Shanghai, China

Ziyun Li[1,2†], Xiaochen Bo[2†], Chen Qian[2†], Mingyue Chen[2], Yuqing Shao[2], Yuxun Peng[2], Ruian Cai[2], Xiaojing Huang[3*], Lijun Wei[4*], Jinzhong Zhao[1*] and Jianwei Shi[5,6*]

[1]Department of Sports Medicine, Shanghai Sixth People's Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, Shanghai, China, [2]School of Public Health, Shanghai Jiaotong University School of Medicine, Shanghai, China, [3]School of Management, Xuzhou Medical University, Xuzhou, China, [4]Shanghai Minhang Wujing Community Healthcare Center, Shanghai, China, [5]Department of General Practice, Yangpu Hospital, Tongji University School of Medicine, Shanghai, China, [6]Department of Social Medicine and Health Management, School of Public Health, Shanghai Jiaotong University School of Medicine, Shanghai, China

**Background:** Musculoskeletal disorders (MSDs) are common occupational diseases. However, the influencing mechanisms were not clear in the new emerging takeaway rider occupation in the catering industry in China.

**Methods:** A cross-sectional study was conducted using a takeaway rider sample from one of the largest e-platforms, the Mei Tuan Company in Shanghai. The chi-square test was used to compare the sex differences in MSDs according to various factors. Binary logistic regressions were then performed to explore the potential risk factors for the occurrence and severity of MSDs adjusted by age, sex and vehicle type. Crude odds ratios (CORs) and adjusted odds ratios (AORs) and their 95% confidence intervals (CIs) for predictors were reported.

**Results:** The prevalence of MSDs was found to be 54.9% ($n = 361$). Shoulders (joint pain: 24.5%, $n = 154/629$ cases; muscle pain: 29.0%, $n = 183/632$ cases; muscle numbness: 31.7%, $n = 120/379$ cases) and neck (joint pain: 17.0%, $n = 107/629$ cases; muscle pain: 14.1%, $n = 89/632$ cases; muscle numbness: 15.3%, $n = 58/379$ cases) were the most affected regions. Irregular meals (often having regular meals: $p = 0.03$, AOR = 1.89, 95% CI: 1.05–3.39; sometimes: $p < 0.01$, AOR = 2.54, 95% CI: 1.49–4.34 and seldomly: $p < 0.01$, AOR = 4.24, 95% CI: 2.28–7.91) were positively associated with the occurrence of MSDs. Work-related factors, including working over 5 years ($p = 0.02$, AOR = 1.87, 95% CI: 1.10–3.17) and over 51 km of food delivery distance per day (51–75 km: $p = 0.02$, AOR = 2.13, 95CI%:1.13–4.01; ≥76 km: $p < 0.01$, AOR = 3.12, 95CI%: 1.44–6.77), were strongly associated with severity.

**Conclusion:** MSDs were common among takeaway riders. Personal lifestyles (meal irregularity) were found to predict the occurrence, while work-related

factors (longer years of employment and prolonged food delivery distance) were positively associated with severity. Public health efforts should be made to prevent MSDs in this population.

KEYWORDS

**work-related factors, musculoskeletal disorders (MSDs), influence, risk factor, takeaway**

# Introduction

Musculoskeletal disorders (MSDs) are a series of common occupational-related disorders in which work exposures play a contributing causal role (1). MSDs can result from cumulative microdamage induced by risk factors at the cellular and/or tissue level over time and include inflammatory and degenerative diseases such as knee osteoarthritis, hip osteoarthritis, and frozen shoulder (2–4). The diseases lead to decreased productivity, work-time loss, or work leave and ultimately result in a large health resource burden (2, 3). Hence, there is a fast-expanding body of knowledge and attention focused on MSDs, as they present a serious threat to public health and place a financial burden on health insurance programs, businesses, and workers (5).

In recent years, takeaway rider occupation in the catering industry has become an emerging vocation and is rapidly increasing in popularity as a result of new business economies in China and other countries (6, 7). Catering service is realized mainly by customers ordering food online, offline merchants preparing food, and takeaway riders delivering food (8). Physical demands for takeaway riders include standing for a prolonged time, lifting items frequently, carrying the take-away food and transferring food from one place to another. As a result, takeaway riders may be susceptible to MSDs.

Sekkay et al. (9) investigated short- and long-distance industrial gas delivery truck drivers in Canada and discovered that among drivers reporting musculoskeletal pain in the past 12 months, the areas with the highest prevalence were the low back (21.1%), shoulders (20.3%), and neck (14.6%). For those reporting musculoskeletal pain in the past 7 days, the areas with the highest prevalence were also the low back (14.6%), shoulders (13.8%), and neck (8.9%) (9). The study found that high effort-reward imbalance, working with hands above shoulders, hand-arm vibration and whole-body vibration were risk factors for MSDs (9). However, the research subjects were truck drivers, whose vehicles are different from those of takeaway riders in the catering industry. Currently, studies of the MSDs of takeaway riders in the catering industry are relatively scarce. Yang et al. (8) investigated 137 takeaway riders in the catering industry with 49.6% (68/137) aged ≤25 years and found that the incidence of MSDs was 67.9%, with the highest prevalence in the neck (35.8%, 49/137) and shoulders (35.8%, 49/137), followed by the lower back (34.3%, 47/137), waist and thigh (34.3%, 47/137) and knee (28.5%, 39/137) (8). In Yang et al.'s (8) study, it was found that hand-arm vibrations were a risk factor for the occurrence of MSDs.

A wide range of work-related factors have already been acknowledged as important risk factors for MSDs, including vibration, prolonged working hours, and posture demands (2, 9–12). Furthermore, personal lifestyle could also greatly influence MSDs. An unhealthy personal lifestyle (including harmful use of tobacco/alcohol, unhealthy food habits and resistance to physical exercise) has been proposed as a risk factor for MSDs, while healthy personal lifestyles such as nap habits are negatively related to MSDs (1, 13).

In conclusion, although factors related to lifestyle and work were considered to be associated with MSDs among various occupational workers, no known research has studied the effects of these risk factors on MSDs for takeaway riders. Few previous papers have investigated the detailed distribution of MSDs symptoms among takeaway riders; also, the risk factors for MSDs occurrence and severity among takeaway riders are unclear. Therefore, this study innovatively investigated the MSDs of takeaway riders in the catering industry in China. The objective was to systematically describe the occurrence of MSDs, the influencing mechanism of possible factors on their occurrence and the severity among takeaway riders in the catering industry in Shanghai, China.

# Methods

## Data sources

In this study, the sample was recruited from the Mei Tuan Company in Shanghai, which is a service e-commerce platform, with a takeaway service as its primary service. By the end of 2019, the total number of takeaway riders reached 3.987 million for one of the largest businesses, the Mei Tuan company, which mainly operated in Beijing, Shanghai, Shenzhen and other large cities (8). Participant recruitment was conducted with the assistance of Mei Tuan's human resources

Abbreviations: MSDs, musculoskeletal disorders.

personnel, and the participants involved were randomly chosen through the extraction of their job numbers. The inclusion criteria were as follows: (1) relevant work experience (over a month working) as takeaway riders and (2) voluntary participation in the survey. From July to August 2021, an online survey was conducted. All participants in this study placed food into a fixed container fixed on the baggage rack without shoulder straps. The questionnaire was named "Health investigation of takeaway riders in Shanghai," with 27 multiple-choice questions included, and it was developed from standardized MSD questionnaires [including the Cornell Musculoskeletal Discomfort Questionnaire, the International Knee Documentation Committee Knee Evaluation Form and the Nordic-Musculoskeletal Questionnaire (14, 15)]. Considering the sample chosen principle, according to the statistical requirement, we first calculated a minimum size of 10 times the number of items in the questionnaire (16). As a result, the 27-item questionnaire required a minimum sample size of 270. Then, we decided to expand the sample to two times 270, which is 540. During our study, before the formal investigation, we conducted a pilot study in June 2021, which covered 100 questionnaires in the Yangpu district, Shanghai. Sixty-nine effective questionnaires were obtained in the pilot study, and the corresponding effective rate was 0.69. Then, for the formal investigation, the final number of questionnaires was calculated and set to 540/0.69 = 783. Trained investigators were assigned to explain all the questions at the questionnaire distributing sites. A total of 783 questionnaires were distributed, and 657 effective questionnaires were obtained (exclusion criteria included missing values >10%, answers that tended to be consistent, etc.), and the effective rate was 83.9%.

## Measures

### Independent variables

In our study, demographic variables included sex, age, height, weight, location of registered household, education level, total monthly family income, type of medical insurance, marital status, the status of living with family and willingness to obtain medical service (17). Additionally, lifestyle variables included regular consumption of meals (always or often or sometimes or seldom or never) and daily sleeping duration (≤6 h or 7–8 h or ≥9 h), in which always, often, sometimes, seldom and never indicated every day, once every 2 to 3 days, once a week, once every 2 or 3 weeks and never. Additionally, the work-related variables were measured, including working status (part-time or full-time), years of employment (<5 years or ≥5 years), daily working hours (<8 or 8–10 h or 11–13 or ≥14 h), daily number of floors climbed (≤10 floors or 11–20 floors or 21–30 floors or ≥31 floors), vehicle type (bicycles or motorcycles/battery powered bikes or vans/cars or other) and daily food delivery distance (≤25 or 26–50 km or 51–75 or ≥76 km).

## Outcome variables

In this study, we measured the various statuses of musculoskeletal symptoms, including (1) the occurrence of symptoms (joint pain, muscle pain and muscle numbness), the injured regions and the duration (duration: never, <1 month, 1–5 months, 6–11 months, 1–2 years and >3 years). Questions involving different symptoms were separately raised. As shoulder joint and muscle pain could be hard to extinguish, we identified joint pain as pain in a deeper site indicating injury in the rotor cuff, scapula, head of humerus and ligaments around the shoulder joint (potentially accompanied by a reduced range of motion), while muscle pain would be more superficial, indicating injuries in the deltoid muscle, latissimus dorsi, and trapezius muscle (18, 19). All information was provided by the participants. (2) Additionally, respondents with MSDs symptoms were selected, and the severity of musculoskeletal symptoms, showing MSDs' impacts on daily life, was measured by a standardized rating scale (Numerical Rating Scale). Scores above four indicated severe disorders, while scores between 1 and 3 indicated minor disorders (20).

## Adjusting variables

Adjusting variables were collected, including sex, age and vehicle type. Age was categorized into 4 groups (18–24 years, 25–30 years, 31–40 years and >40 years) based on WHO suggestions for Asian regions and the internal distribution (21).

## Statistical analysis

SPSS software (SPSS 25.0, Chicago, IL, USA) was used for data analysis. First, we described demographic factors, lifestyle factors, working conditions and musculoskeletal symptom information. Then, the chi-square test was performed to compare the differences in various factors between sexes. Finally, two binary logistic regression models were constructed to explore potential risk factors for occurrence and severity, and both were adjusted by age, sex and vehicle type. Crude odds ratios (CORs) and adjusted odds ratios (AORs) and their 95% confidence intervals (CIs) for predictors were reported.

# Results

## Participant demographics, lifestyle factors, and work-related factors

As shown in Table 1, of all 657 respondents, 70.9% ($n$ = 466) were male, and most were aged 18–24 years ($n$ = 317,

TABLE 1 Distribution of demographics and possible influencing factors.

| Variables classification | Total ($N = 657$) | Male ($N = 466$) | Female ($N = 191$) | $p$-values |
|---|---|---|---|---|
| **Demographics** | | | | |
| **Age** | | | | |
| 18–24 years | 317 (48.3%) | 238 (51.1%) | 79 (41.4%) | <0.01 |
| 25–30 years | 182 (27.7%) | 127 (27.3%) | 55 (28.8%) | |
| 31–40 years | 104 (15.8%) | 76 (16.3%) | 28 (14.7%) | |
| >40 years | 54 (8.2%) | 25 (5.4%) | 29 (15.2%) | |
| **BMI** | | | | |
| Underweight (<18.5) | 65 (9.9%) | 28 (6.0%) | 37 (19.4%) | <0.01 |
| Normal (18.5–23.9) | 373 (56.8%) | 264 (56.7%) | 109 (57.1%) | |
| Overweight (24–27.9) | 153 (23.3%) | 121 (26.0%) | 32 (16.8%) | |
| Obese (≥28) | 66 (10.1%) | 53 (11.4%) | 13 (6.8%) | |
| **Household registration** | | | | |
| Shanghai | 198 (30.1%) | 142 (30.5%) | 56 (29.3%) | 0.77 |
| Other cities | 459 (69.9%) | 324 (69.5%) | 135 (70.7%) | |
| **Education** | | | | |
| Junior high school or below | 140 (21.3%) | 100 (21.5%) | 40 (20.9%) | 0.2 |
| Senior high school | 154 (23.4%) | 119 (22.5%) | 35 (18.3%) | |
| Junior college | 159 (24.2%) | 110 (23.6%) | 49 (25.7%) | |
| Bachelor's degree or above | 204 (31.1%) | 137 (29.4%) | 67 (35.1%) | |
| **Monthly household income (RMB)** | | | | |
| <5,000 | 152 (23.1%) | 92 (19.7%) | 60 (31.4%) | 0.01 |
| 5,000–9,999 | 249 (37.9%) | 190 (40.8%) | 59 (30.9%) | |
| ≥10,000 | 187 (28.5%) | 137 (29.4%) | 50 (26.2%) | |
| Unknown | 69 (10.5%) | 47 (10.1%) | 22 (11.5%) | |
| **Medical insurance** | | | | |
| Shanghai medical insurance | 197 (30.0%) | 142 (30.5%) | 55 (28.8%) | 0.39 |
| Other cities medical insurance | 188 (28.6%) | 125 (26.8%) | 63 (33.0%) | |
| New rural cooperative medical insurance | 92 (14.0%) | 65 (13.9%) | 27 (14.1%) | |
| Commercial medical insurance | 109 (16.6%) | 78 (16.7%) | 31 (16.2%) | |
| No medical insurance | 71 (10.8%) | 56 (12.0%) | 15 (7.9%) | |
| **Marital status** | | | | |
| Unmarried | 439 (66.8%) | 334 (71.7%) | 105 (55.0%) | <0.01 |
| Married | 165 (25.1%) | 98 (21.0%) | 67 (35.1%) | |
| Divorced/Widowed | 53 (8.1%) | 34 (7.3%) | 19 (9.9%) | |
| **Living with family members** | | | | |
| Yes | 417 (63.5%) | 287 (61.6%) | 130 (68.1%) | 0.12 |
| No | 240 (36.5%) | 179 (38.4%) | 61 (31.9%) | |
| **Willingness to seek medical service** | | | | |
| Yes | 563 (85.7%) | 404 (86.7%) | 159 (83.2%) | 0.25 |
| No | 94 (14.3%) | 62 (13.3%) | 32 (16.8%) | |
| **Lifestyle variables** | | | | |
| **Regularity of meals** | | | | |
| Always | 88 (13.4%) | 66 (14.2%) | 22 (11.5%) | <0.01 |
| Often | 128 (19.5%) | 75 (16.1%) | 53 (27.7%) | |
| Sometimes | 227 (34.6%) | 154 (33.0%) | 73 (38.2%) | |
| Seldom | 113 (17.2%) | 87 (18.7%) | 26 (13.6%) | |
| Never | 101 (15.4%) | 84 (18.0%) | 17 (8.9%) | |

*(Continued)*

TABLE 1 (Continued)

| Variables classification | Total ($N = 657$) | Male ($N = 466$) | Female ($N = 191$) | $p$-values |
|---|---|---|---|---|
| **Daily sleep duration** | | | | |
| ≤6 h | 218 (33.2%) | 143 (30.7%) | 75 (39.3%) | 0.02 |
| 7–8 h | 357 (54.3%) | 256 (54.9%) | 101 (52.9%) | |
| ≥9 h | 82 (12.5%) | 67 (14.4%) | 15 (7.9%) | |
| **Work-related variables** | | | | |
| **Working status** | | | | |
| Full-time | 260 (39.6%) | 200 (42.9%) | 60 (31.4%) | 0.01 |
| Part-time | 397 (60.4%) | 266 (57.1%) | 131 (68.6%) | |
| **Years of employment** | | | | |
| <5 years | 493 (75.0%) | 345 (74.0%) | 148 (77.5%) | 0.35 |
| ≥5 years | 164 (25.0%) | 121 (26.0%) | 43 (22.5%) | |
| **Daily working hours** | | | | |
| <8 h | 302 (46.0%) | 197 (42.3%) | 105 (55.0%) | 0.01 |
| 8–10 h | 263 (40.0%) | 193 (41.4%) | 70 (36.6%) | |
| 11 13 h | 69 (10.5%) | 55 (11.8%) | 14 (7.3%) | |
| ≥14 h | 23 (3.5%) | 21 (4.5%) | 2 (1.0%) | |
| **Daily number of floors climbed** | | | | |
| ≤10 floors | 260 (39.6%) | 169 (36.3%) | 91 (47.6%) | <0.01 |
| 11–20 floors | 193 (29.4%) | 131 (28.1%) | 62 (32.5%) | |
| 21–30 floors | 103 (15.7%) | 78 (16.7%) | 25 (13.1%) | |
| ≥31 floors | 101 (15.4%) | 88 (18.9%) | 13 (6.8%) | |
| **Vehicle type** | | | | |
| Bicycles | 72 (11.0%) | 59 (12.7%) | 13 (6.8%) | 0.02 |
| Motorcycles/battery powered bikes | 539 (82.0%) | 373 (80.0%) | 166 (86.9%) | |
| Vans/cars | 37 (5.6%) | 30 (6.4%) | 7 (3.6%) | |
| Other | 9 (1.4%) | 5 (2.6%) | 4 (0.9%) | |
| **Daily food delivery distance** | | | | |
| ≤25 km | 214 (32.6%) | 135 (29.0%) | 79 (41.4%) | <0.01 |
| 26–50 km | 168 (25.6%) | 119 (25.5%) | 49 (25.7%) | |
| 51–75 km | 154 (23.4%) | 113 (24.2%) | 41 (21.5%) | |
| ≥76 km | 121 (18.4%) | 99 (21.2%) | 22 (11.5%) | |

48.3%) and had a normal BMI ($n = 373$, 56.8%). Most were unmarried ($n = 439$, 66.8%), lived with their family members ($n = 417$, 63.5%), and had a household registration outside Shanghai ($n = 459$, 69.9%). A total of 140 respondents (21.3%) did not finish senior high school, and 152 (23.1%) had a monthly household income lower than 5,000 RMB. Almost all respondents were willing to seek medical service ($n = 563$, 85.7%), but 10.81% ($n = 71$) did not have any kind of medical insurance. Regarding personal lifestyles, only 13.4% ($n = 88$) always consumed meals regularly, and 54.3% ($n = 357$) had adequate sleep, with a 7–8 h sleeping duration. Regarding work-related factors, most of the participants had part-time jobs ($n = 397$, 60.4%) and were employed for <5 years ($n = 493$, 75.0%). The majority preferred motorcycles or battery-powered bikes ($n = 539$, 82.04%), and only 46.0% ($n = 302$) worked <8 h per day (Table 1).

Compared to males, age ($p < 0.01$), BMI index ($p < 0.01$), monthly household income ($p = 0.01$), and marital status ($p < 0.01$) in female riders were significantly different from those in males. Regarding lifestyle variables, regularity in meals ($p < 0.01$) and daily sleep duration ($p = 0.02$) were also different between the sexes. For work-related factors, female riders were more likely to have a part-time job (68.6 vs. 58.1%, $p = 0.01$), and differences were also found in daily working hours ($p = 0.01$), daily number of floors climbed ($p < 0.01$), vehicle type ($p = 0.02$) and daily food delivery distance ($p < 0.01$).

## Status of participants' MSDs

The prevalence of MSDs in this study was 54.94% ($n = 361$). Each symptom was demonstrated as an injured region,

10.3389/fpubh.2022.988724

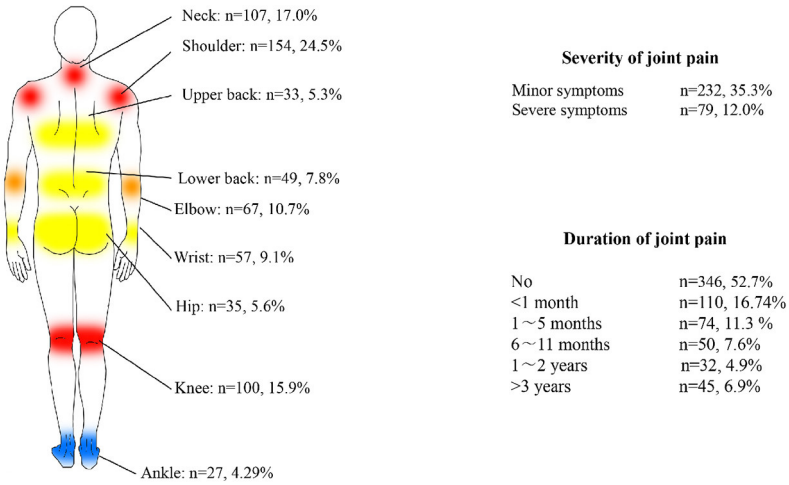


Figure 1a. The injured regions, severity and duration of joint pain (629 cases)

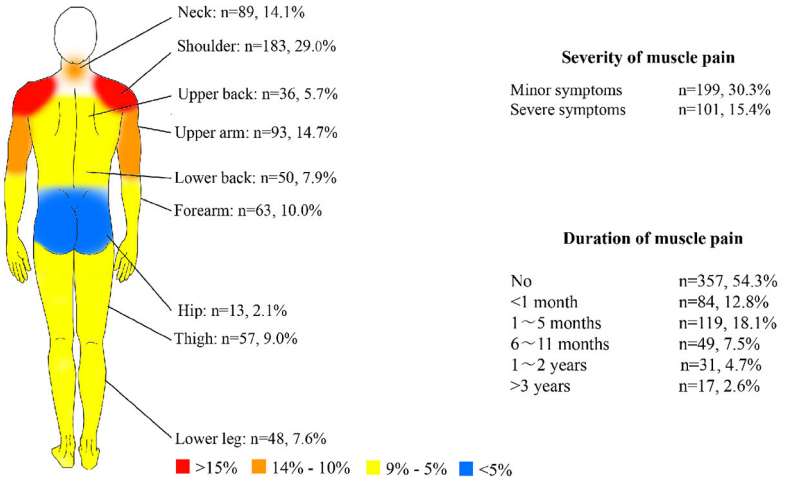


Figure 1b. The injured regions, severity and duration of muscle pain (623 cases)

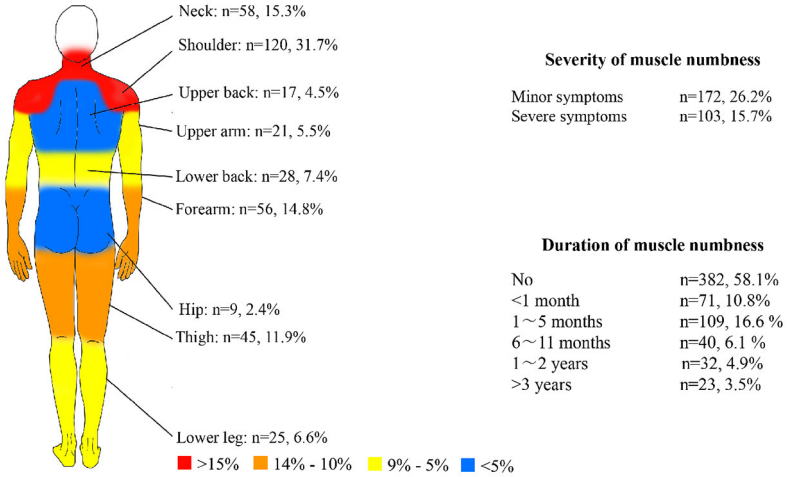


Figure 1c. The injured regions, severity and duration of muscle numbness (379 cases)

FIGURE 1
The injured regions, severity and duration of MSD symptoms.

TABLE 2 Possible influencing factors of the occurrence of MSDs symptoms.

| Factors | Occurrence of symptoms | | | |
|---|---|---|---|---|
| | COR (95% CI) | *p*-value | AOR* (95% CI) | *p*-value |
| **Lifestyle variables** | | | | |
| **Regularity of meals** | | | | |
| Always | ref. | | ref. | |
| Often | 1.83 (1.04–3.23) | 0.04 | 1.89 (1.05–3.39) | 0.03 |
| Sometimes | 2.52 (1.50–4.25) | <0.01 | 2.54 (1.49–4.34) | <0.01 |
| Seldom | 4.28 (2.32–7.89) | <0.01 | 4.24 (2.28–7.91) | <0.01 |
| Never | 1.19 (0.65–2.16) | 0.58 | 1.15 (0.62–2.13) | 0.66 |
| **Daily sleep duration** | | | | |
| ≤6 h | 1.24 (0.86–1.80) | 0.25 | 1.25 (0.86–1.83) | 0.24 |
| 7–8 h | ref. | | ref. | |
| ≥9 h | 1.72 (1.01–2.91) | 0.05 | 1.63 (0.94–2.80) | 0.08 |
| **Work-related variables** | | | | |
| **Working status** | | | | |
| Full-time | ref. | | ref. | |
| Part-time | 1.16 (0.81–1.66) | 0.42 | 1.17 (0.81–1.69) | 0.41 |
| **Years of employment** | | | | |
| <5 years | ref. | | ref. | |
| ≥5 years | 1.14 (0.78–1.67) | 0.50 | 1.07 (0.72–1.58) | 0.73 |
| **Daily working hours** | | | | |
| <8 h | ref. | | ref. | |
| 8–10 h | 1.36 (0.93–2.01) | 0.12 | 1.34 (0.91–1.99) | 0.14 |
| 11 13 hours | 1.25 (0.69–2.27) | 0.46 | 1.22 (0.67–2.24) | 0.52 |
| ≥14 hours | 1.12 (0.44–2.83) | 0.81 | 1.14 (0.45–2.90) | 0.78 |
| **Daily number of floors climbed** | | | | |
| ≤10 floors | ref. | | ref. | |
| 11–20 floors | 1.19 (0.78–1.81) | 0.41 | 1.25 (0.81–1.92) | 0.31 |
| 21–30 floors | 1.19 (0.70–2.03) | 0.52 | 1.21 (0.70–2.08) | 0.50 |
| ≥31 floors | 1.26 (0.71–2.22) | 0.43 | 1.29 (0.72–2.31) | 0.39 |
| **Daily food delivery distance** | | | | |
| ≤25 km | ref. | | ref. | |
| 26–50 km | 0.68 (0.43–1.10) | 0.12 | 0.70 (0.43–1.14) | 0.25 |
| 51–75 km | 0.67 (0.43–1.05) | 0.08 | 0.68 (0.43–1.07) | 0.10 |
| ≥76 km | 0.63 (0.37–1.08) | 0.09 | 0.63 (0.36–1.08) | 0.09 |

Note: ref.: reference; *: adjusted for sex, age and vehicle type.

and the severity and duration are shown in Figure 1. The top three regions with the highest prevalence of joint pain were the shoulder (24.5%, $n = 154/629$ cases), neck (17.0%, $n = 107/629$ cases) and knee (15.9%, $n = 100/629$ cases). For muscle pain, the top three regions were the shoulder (29.0%, $n = 183/632$ cases), upper arm (14.7%, $n = 93/632$ cases) and neck (14.1%, $n = 89/632$ cases). For muscle numbness, the top three regions were the shoulder (31.7%, $n = 120/379$ cases), neck (15.3%, $n = 58/379$ cases), and forearm (14.8%, $n = 56/379$ cases). Data of severity and duration are shown in Figure 1.

## Association between MSDs and possible influencing factors

Regarding the occurrence of symptoms, several influencing factors were associated with the occurrence of symptoms. Specifically, we found that those who often ($p = 0.03$, AOR = 1.89, 95% CI: 1.05–3.39), sometimes ($p < 0.01$, AOR = 2.54, 95% CI: 1.49∼4.34) or seldomly ($p < 0.01$, AOR = 4.24, 95% CI: 2.28–7.91) ate regularly were more likely to be symptomatic than their counterparts (Table 2).

Regarding the severity of symptoms, the logistic regression showed that those who worked ≥5 years were 1.87 times more likely to have more severe symptoms than to have minor symptoms ($p = 0.02$, AOR = 1.87, 95% CI: 1.10–3.17). Additionally, long food delivery distance was a factor related to developing more severe symptoms, especially for the 51–75 km group ($p = 0.02$, AOR = 2.13, 95CI%:1.13–4.01) and the ≥76 km group ($p < 0.01$, AOR = 3.12, 95CI%: 1.44–6.77) (Table 3).

# Discussion

This research innovatively focused on the globally booming industry of delivery service and the prevention of MSDs among takeaway riders. We identified joint pain, muscle pain and muscle numbness as major symptoms and found that the prevalence was 54.95%, similar to that in Yang et al. (8) study on 150 takeaway riders (67.9%). The results showed that MSDs are a significant public health concern and are particularly prevalent among takeout riders. The prevalence in our research was slightly higher than that in Sekkay's et al. (9) study (43.1%), mainly because their research was focused on truck drivers, while the subjects in our study were mostly motorcycle or battery-powered bike riders (82.04%). Similarly, Matysiak et al. (22) found a prevalence of 57.37% in 337 police riders.

In our study, several hazards were identified for the takeaway riders. It was found that males and those below the age of 30 years old suffered more from MSDs. Most takeaway riders led a less healthy lifestyle, with 13.39% having meals regularly on a daily basis and only 54.34% having adequate sleeping habits. Regarding work-related information, high job mobility was observed in this population, with the majority of participants having part-time jobs (60.43%) and <5 years of employment (77.47%). Additionally, most of the participants preferred riding motorcycles or battery-powered bikes (82.04%). Regarding the MSDs, the most commonly injured regions in our study were the shoulders and neck, similar to the findings of Yang's study (8). However, Sekkay et al. found that the low back was the region with the highest prevalence, which might also be explained by the different types of vehicles used (9).

Regarding the occurrence of symptoms, unlike previous studies on MSDs that found work-related factors as risk factors,

TABLE 3 Possible influencing factors of the severity of MSDs symptoms.

| Factors | Severity of symptoms | | | |
|---|---|---|---|---|
| | COR (95% CI) | *p*-value | AOR* (95% CI) | *p*-value |
| **Lifestyle variables** | | | | |
| **Regularity of meals** | | | | |
| Always | ref. | | ref. | |
| Often | 1.64 (0.65–4.14) | 0.30 | 1.87 (0.71–4.94) | 0.21 |
| Sometimes | 0.91 (0.39–2.14) | 0.82 | 1.06 (0.43–2.58) | 0.91 |
| Seldom | 0.93 (0.38–2.31) | 0.88 | 1.06 (0.41–2.73) | 0.91 |
| Never | 1.75 (0.63–4.86) | 0.29 | 1.66 (0.57–4.79) | 0.35 |
| **Daily sleep duration** | | | | |
| ≤6 h | 1.14 (0.69–1.89) | 0.62 | 1.08 (0.63–1.83) | 0.78 |
| 7–8 h | ref. | | ref. | |
| ≥9 h | 1.91 (0.98–3.73) | 0.06 | 1.63 (0.80–3.30) | 0.18 |
| **Work-related variables** | | | | |
| **Working status** | | | | |
| Full-time | ref. | | ref. | |
| Part-time | 1.53 (0.92–2.54) | 0.11 | 1.43 (0.84–2.44) | 0.19 |
| **Years of employment** | | | | |
| <5 years | ref. | | ref. | |
| ≥5 years | 2.00 (1.20–3.33) | 0.01 | 1.87 (1.10–3.17) | 0.02 |
| **Daily working hours** | | | | |
| <8 h | ref. | | ref. | |
| 8–10 h | 0.76 (0.45–1.30) | 0.32 | 0.72 (0.42–1.25) | 0.25 |
| 11–13 h | 1.30 (0.58–2.94) | 0.52 | 1.45 (0.63–3.37) | 0.39 |
| ≥14 h | 2.47 (0.54–11.20) | 0.24 | 2.60 (0.58–11.72) | 0.21 |
| **Daily number of floors climbed** | | | | |
| ≤10 floors | ref. | | ref. | |
| 11–20 floors | 1.30 (0.73–2.30) | 0.37 | 1.28 (0.70–2.34) | 0.42 |
| 21–30 floors | 1.49 (0.72–3.07) | 0.28 | 1.48 (0.69–3.18) | 0.31 |
| ≥31 floors | 1.14 (0.52–2.51) | 0.74 | 1.13 (0.50–2.55) | 0.77 |
| **Daily food delivery distance** | | | | |
| ≤25 km | ref. | | ref. | |
| 26–50 km | 1.40 (0.74–2.65) | 0.30 | 1.21 (0.61–2.38) | 0.58 |
| 51–75 km | 2.24 (1.22–4.12) | 0.01 | 2.13 (1.13–4.01) | 0.02 |
| ≥76 km | 2.82 (1.35–5.92) | 0.01 | 3.12 (1.44–6.77) | <0.01 |

Ref., reference; *: adjusted for sex, age and vehicle type.

we discovered that intermittent irregular eating was an obvious risk factor. This could be explained by the younger age of takeaway riders. Contrary to other reports whose subjects were mostly middle-aged adults (1, 9), our respondents were mostly young adults aged 18–24 years who naturally are not in the peak age of degenerative diseases caused by cumulative micro damage (4, 23). Thus, riders' personal characteristics, namely, their long-term personal lifestyle, play a more important role in the onset of MSDs (24). A South Korean survey also found that temporary workers were more likely to skip meals than permanent workers, especially in the case of lunch (25). It is well-known that irregular meals do great harm to health, since skipping meals was associated with lower dietary quality as well as reduced healthy food purchases (26, 27) and thus led to obesity, diabetes, cardiovascular diseases and mental health problems (28, 29). Interestingly, when irregularity is then subdivided, intermittent irregular eating habits may cause more physical and psychological disorders by influencing metabolic and anxiolytic properties with consequent effects on daily activity levels due to the unreliable prediction of food availability (30). A study on surgeons also confirmed this finding that intermittent eating irregularly can lead to hypoglycaemia, electrolyte imbalance, psychological stress, sleep deprivation, and fatigue (31), which are all precursors of musculoskeletal injuries. Future studies will need to confirm these first findings in workers. Therefore, it can be suggested that personal lifestyle habits, especially a healthy diet, greatly affected the health of takeaway riders, and public health interventions should more actively encourage the adoption of mandatory breaks to improve the regularity of meal consumption to help reduce the risk of musculoskeletal disorders.

Our study adopted a rating scale to measure the severity of symptoms (20), and we discovered that although work-related factors are not associated with the onset of MSDs, they have a profound influence on the further deterioration of MSDs. Having been employed over 5 years and over 51 km of food delivery distance per day were found to be risk factors for severe symptoms. The harm associated with the workload may be related to the process of food delivery. Posture fatigue problems exist in motorcycle or battery-powered bike riders since a high volume of non-neutral postures in riding (e.g., excessive elongation of the neck) could lead to kinematic alterations in the shoulder, neck, lower body and spinal structures, causing muscle stiffness and pain and finally resulting in more severe MSDs (32, 33). Moreover, hand-arm vibration during the riding process made riders more inclined to grip handles, leading to increased static muscle activity in the arms, neck and shoulders, which was shown to harm the upper limbs in a meta-analysis (34). The vertical vibration caused by sitting on a backless seat could also injure the lower part of the body, since the hips and lower back absorb the vibration energy directly (35). Overall, prolonged years of employment and food delivery distance were associated with the severity of symptoms. On the basis of these results, health policies should focus more on lowering working hours and increasing working wages to reduce working load, as well as promoting ergonomic protection devices, thus protecting musculoskeletal systems.

There were some limitations in this study. First, the sample was from Shanghai, and a representative study needs to be based on a larger population from other regions in China. Second, there may be recall bias in the study, since symptomatic subjects might tend to recall more risk factors than their non-symptomatic counterparts.

## Conclusions

This research provides an innovative detailed examination of the MSDs of takeaway riders, which is an occupation that is rapidly developing in most countries. We discovered that the prevalence of MSDs was rather high among takeaway riders, and the most injured regions were the shoulders and neck. Additionally, personal lifestyles (meal irregularity) were found to be positively involved in the occurrence of musculoskeletal symptoms, and work-related factors (longer years of employment and prolonged food delivery distance) were more likely to predict an increase in symptom severity. Public health policies should pay more attention to increasing rest time and decreasing working hours among takeaway riders to establish better lifestyles and reduce working loads to help prevent MSDs.

## 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 authors.

## Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committees of Tongji University (ref: LL-2016-ZRKX-017). The patients/participants provided their written informed consent to participate in this study.

## Author contributions

ZL, XB, and CQ performed the statistical analysis and drafted the manuscript. ZL, XH, LW, JZ, and JS participated in the design of the study and revision of the paper. ZL, XB, CQ, YS, YP, RC, and MC participated in the data collection. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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Grace Sembajwe,
Northwell Health, United States

REVIEWED BY
MirHossein Aghaei,
Ardabil University of Medical Sciences, Iran
Akon Emmanuel Ndiok,
University of Calabar, Nigeria
Zhizheng Zhuo,
Beijing Tiantan Hospital, Capital Medical University, China

*CORRESPONDENCE
Nan Bi
binan_email@163.com
Xiangyu Ma
mxyccmu@sina.com

†These authors have contributed equally to this work

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# The impact of the COVID-19 pandemic on palliative care practice: A survey of clinical oncologists

Yu Wang[1†], Yilin Huang[2†], Xiangyu Ma[1*], Dilinaer Wusiman[3], Xinqing Zhang[4] and Nan Bi[1*]

[1]Department of Radiation Oncology, National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Peking Union Medical College and Chinese Academy of Medical Science, Beijing, China, [2]State Key Laboratory of Cardiovascular Disease, Division of Prevention and Community Health, National Center for Cardiovascular Disease, National Clinical Research Center of Cardiovascular Disease, Fuwai Hospital, Peking Union Medical College and Chinese Academy of Medical Sciences, Beijing, China, [3]Department of Head and Neck Surgery, National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Peking Union Medical College and Chinese Academy of Medical Sciences, Beijing, China, [4]School of Humanities and Social Sciences, Peking Union Medical College, Beijing, China

**Background:** Palliative care is an essential intervention to improve the quality of life for patients with cancer, whereas the ongoing COVID-19 pandemic poses a challenge to supportive and palliative care providers. This survey aims to explore the current status of palliative care practice for cancer and the influence of COVID-19, from the perspective of oncologists.

**Methods:** The semi-structure electronic questionnaire was designed. Mixed-mode surveys including electronic questionnaires, face-to-face interactions, and telephone interviews were adopted according to the willingness of respondents. Face-to-face and telephone interviews were based on same questions in the online questionnaire. Participants working in cancer-related departments with frontline palliative care experience during the COVID-19 outbreak were included. Surveys covered experiences and perspectives regarding the impact of COVID-19 on clinical work, personal lives, and palliative care practice. Suggestions on coping strategies were further proposed and qualitatively analyzed.

**Results:** Thirty-seven oncologists participated in this study from September 2021 to January 2022. The majority of them believed COVID-19 significantly and negatively affected their clinical work routines (75.7%), personal daily lives (67.6%), and palliative care practice (64.9%). Most specialists considered that currently the palliative care system remained underdeveloped (73.0%), and other factors besides COVID-19 were associated with this situation (78.4%). Seventeen participants further made suggestions on how to promote palliative care during COVID-19, and three themes emerged through the qualitative analysis: (1) Remote or online service (88.2%); (2) Publicity, education, or shared decision-making for patients (29.4%); (3) Guidelines, training, or programs for care providers (23.6%).

**Conclusion:** Oncologists consider that COVID-19 has an adverse impact on their palliative care practice and daily routine. In addition to

COVID-19, other factors affecting palliative care should not be neglected. Corresponding measures are warranted to encourage palliative care practice during COVID-19.

KEYWORDS

palliative care, COVID-19, pandemic, oncologist, survey

## Introduction

In December 2019, coronavirus diseases 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged in China. Subsequently, COVID-19 has rapidly become a severe pandemic and significantly impacted various clinical practices (1, 2). Although the global mortality rate estimated by the World Health Organization (WHO) was 3.4%, mortality and morbidity rates tend to be higher among older people and cancer patients (1, 3). The outbreak of the COVID-19 pandemic results in a global shortage of healthcare resources, presumably including supportive and palliative care resources and applications, especially for the large number of patients with cancer (4). At present, cancer remains the leading cause of worldwide medical burden and brings tremendous physical and mental stress on patients and their families (5). Palliative care is an essential component of the cancer comprehensive treatment, aiming to alleviate the suffering and improve the quality of life (6). Given that COVID-19 is expected to surpass our capacity to provide supportive and palliative care to all patients, which poses a unique challenge to healthcare teams of rationing care during pandemic when resources are scarce (4), in-depth investigations on the specific impact of the ongoing COVID-19 pandemic on the clinical practice of palliative care for cancer patients as well as effective coping strategies are necessary.

The two-sides of practice indicates that one side is the recipient of care and the other side is for the care providers. Thus, both care practitioners and patients play an important role in the practice of palliative care. With early studies suggesting that cancer patients are particularly susceptible to COVID-19, the current pandemic is forcing oncology professionals to explore and practice more (3, 7, 8). Meanwhile, not only vulnerable patients affected by COVID-19 should be concerned, but also palliative care practitioners. The experiences, perspectives and thoughts of care providers during COVID-19 are of great importance and value, even though sometimes we may mainly focus on patients and neglect that doctors are passive sufferers of the COVID-19 pandemic as well. In fact, the health care workers struggling to cope with the current situation face more stress and anxiety, due to the heavier medical burden under COVID-19 and their overwork (9). The fact that the medical staff come so close to the disease puts their mental health at a higher risk than the general population (10). Recently, an increasing prevalence of mental health symptoms has been reported among physicians who had direct contact with infected patients (11, 12). With the explosive growth of the number of diagnosed COVID-19 cases, the stress, anxiety, depression, and feelings of negativity became more and more common in Chinese medical workers (13, 14).

With the increasing difficulty to provide palliative care during the COVID-19 pandemic, the wide emphasis on the experiences and viewpoints of palliative care providers, as well as the urgent need for useful coping strategies to better tackle the influence of COVID-19 on palliative care practice, this survey was conducted in order to shed light on these issues. We not only explored the impact of the COVID-19 pandemic on the clinical practice of supportive and palliative care for patients with cancer, from the perspective of oncologists, but also proposed some useful countermeasures to promote and encourage the clinical practice of palliative care during COVID-19.

## Materials and methods

### Study design

We designed a semi-structured electronic questionnaire to elicit the perspectives of clinical oncologists through both quantitative and open-ended qualitative questions. Mixed-mode surveys including online electronic questionnaires, face-to-face interactions, and telephone interviews were adopted based on the willingness of respondents. If they agreed to receive face-to-face or telephone surveys, they would be individually asked the same questions in the online electronic questionnaire in person, and the information was collected. After obtaining permission from respondents in face-to-face and telephone surveys, all interviews were digitally recorded and transcribed verbatim to assure accuracy. If participants chose to answer the electronic questionnaire, they would complete a self-administered anonymous web-based questionnaire in both Chinese and English. The Independent Ethics Committee of National Cancer Center approved this research. Informed consent was obtained from all individual participants included in the study. They can access the online Participant Information Consent Form via a secure web link and complete it using mobile phones or computers. After the completion of survey,

participants could receive an e-card gift and a thank-you note *via* email, if they were willing to provide their email addresses and some other personal information only for this purpose.

## Participants and study setting

The study was conducted from September 2021 to January 2022 in China. In the approximately two-year pandemic background, this survey was primarily in the setting where palliative care was provided for cancer patients during the COVID-19 period, including medical centers, hospitals, nursing homes, palliative care institutions, community healthcare centers, etc.

Eligible participants were those over 18 years of age currently working in cancer-related departments, such as the department of medical oncology, radiation oncology and surgical oncology, etc, in medical establishments or other sites that provide palliative care practice. Among them, oncologists who had clinical front-line working experiences during the COVID-19 pandemic (from December 2019 to the date participating in the survey), possessed and were able to use online electronic mobile devices autonomously, and proficiently mastered Chinese or English language, were finally included.

## Survey content

The questionnaire survey or interview outline covered: (1) Demographic characteristics: Age, gender, country, educational attainment, workplace and currently working department, supportive and palliative care training experience, the primary place of palliative care practice.

(2) Subjective perceptions regarding the influence of the COVID-19 pandemic: Do you think the COVID-19 pandemic has a significant impact on your clinical work in oncology? Yes, mainly negative impacts. / Yes, mainly positive impacts. / No. / Other. Do you think the COVID-19 pandemic has a significant impact on your personal life or daily routine? Yes, mainly negative impacts. / Yes, mainly positive impacts. / No. / Other. Do you think the COVID-19 pandemic has a significant impact on clinical practice of palliative care for cancer patients? Yes, mainly negative impacts. / Yes, mainly positive impacts. / No. / Other.

(3) Subjective perspectives regarding the status quo of palliative care: Do you agree that the current supportive and palliative care system in your working environment is adequate or fully developed? Yes. / No. / I am not sure. / Other. Do you agree that other factors, except for the influence of COVID-19, are associated with the current status of palliative care practice system? Yes. / No. / I am not sure. / Other.

(4) Suggestions and advice: Do you have any suggestions to improve the clinical practice of palliative care during the COVID-19 pandemic? If yes, please give your precious and specific advice.

## Data collection and analysis

Data was collected from the electronic questionnaire surveys and interviews on oncologists in China from September 2021 to January 2022. Demographics and subjective perspectives of respondents were quantitatively summarized mainly using descriptive statistics. Personal suggestions of free-text narrative responses were qualitatively analyzed through inductive thematic analyses. All data were translated into English before analysis. All face-to-face and telephone interview surveys were digitally recorded and transcribed verbatim by two researchers (W.Y. and X.M.) together to assure maximum accuracy. Two investigators (W.Y. and D.W.), without previous knowledge of the participants and not involved in the distribution of questionnaires, independently collected and analyzed the questionnaire content, and they further compared and verified their research results. Any discrepancies between two researchers (W.Y. and D.W.), especially in summarizing countermeasures proposed by participants, were solved by consulting senior investigators (X.Z. and N.B.).

# Results

Thirty-seven eligible clinical oncologists participated in this study. Among them, 32 (86.5%) were surveyed by online questionnaires, 4 (10.8%) by face-to-face interviews, and 1 (2.7%) by a telephone interview. The baseline demographic characteristics were presented in Table 1. All 37 participants were from China, including 29 (78.4%) males. The median age was 40 (22–56). A large proportion of them had doctoral degrees (67.6%) and worked in urban areas (81.1%). One-third (32.4%) participants were from the department of radiation oncology, 24.3% from medical oncology, and 16.2% from surgical oncology. Meanwhile, clinicians were more likely to practice palliative care in medical centers or hospitals (70.3%) than in the community or elsewhere (29.7%) in China. However, only 10.8% of them had obtained the accredited professional training certification in palliative medicine, and most were with non-accredited training experience (56.8%).

In terms of subjective perceptions and opinions with respect to the impact of COVID-19, the majority of participants agreed that the COVID-19 pandemic had a significantly negative effect on their clinical work in the cancer field (75.7%, Figure 1A), as well as their daily routines or personal lives (67.6%, Figure 1B). In addition, as many as of 64.9% specialists considered that the clinical practice of palliative care for cancer patients had been significantly and negatively affected (Figure 1C). Moreover, 2 (5.4%) oncologists believed that the current supportive and

TABLE 1 Demographic characteristics of survey participants ($n = 37$).

| | Participants *n* (%) |
|---|---|
| **Age (median, range), years** | **40 (25–56)** |
| **Gender** | |
| Male | 29 (78.4) |
| Female | 8 (21.6) |
| **Country** | |
| China | 37 (100) |
| Other | 0 |
| **Educational attainment** | |
| MD or PhD | 25 (67.6) |
| Master degree | 10 (27.0) |
| Undergraduate degree | 2 (5.4) |
| **Urban or rural workplace** | |
| Urban | 30 (81.1) |
| Rural or other | 7 (18.9) |
| **Currently working department** | |
| Radiation oncology | 12 (32.4) |
| Medical oncology | 9 (24.3) |
| Surgical oncology | 6 (16.2) |
| Other | 10 (27.0) |
| **Training in palliative medicine** | |
| Accredited training | 4 (10.8) |
| Non-accredited training | 21 (56.8) |
| No training or other condition | 12 (32.4) |
| **Place of palliative care practice** | |
| Medical center/hospital | 26 (70.3) |
| Community or other | 11 (29.7) |

palliative care system was fully developed in China, while 73.0% of them deemed that it remained underdeveloped. It was quite common for them to agree that many other factors besides COVID-19 were associated with this present status (78.4%), but 2.7% of participants disagreed with that.

Furthermore, a total of 17 specialized physicians proposed their suggestions on how to tackle the adverse influence of COVID-19 on palliative care practice. The qualitative analysis resulted in the following three themes: (1) Remote or online service (88.2%); (2) Publicity, education, or shared decision-making for patients (29.4%); (3) Guidelines, training, or programs for care providers (23.6%). We reported some suggestions made by participants (P) in Box 1.

A total of 17 participants (including P2, P5, P9, P11, P16, P19, P20, P24, P25, P27, P29, P31, P32, P33, P34, P36, and P37) answered the free-text questions and gave their narrative suggestions on coping strategies. Among them, P32, P33, P34, P36, and P37 were interviewed face to face or by telephone. These suggestions were also summarized in Figure 2, which included offering more online guidance on palliative care for cancer patients and their families (35.3%), promoting remote multidisciplinary cooperation (29.4%), strengthening home-based palliative care (17.6%), encouraging shared decision-making during the practice (17.6%), increasing the publicity and education of palliative medicine (11.8%), standardizing palliative care training for medical workers (11.8%), using modern technology in supportive care practice (5.9%), enhancing personalized palliative care programs (5.9%), and updating palliative care guidelines with more information on COVID-19 (5.9%).

## Discussion

It is known that the integration of team-based, timely and targeted supportive and palliative care into standard oncology care for all patients with cancer is of great significance (15). The characteristics of palliative care mainly lie in the team-based care, allowing the interdisciplinary members to address comprehensively the multi-dimensional care needs of patients and their caregivers; the timely intervention, becoming preventative care to minimize crises at the end-of-life; and the targeted treatment, referring to the identification of the patient most likely to benefit from a specialized palliative treatment (15). Nevertheless, palliative care services are under-resourced at the best of times (16). To date, providing effective palliative care has become more and more difficult for specialists, as worldwide health systems become strained under the ongoing COVID-19 pandemic (16). Therefore, we have conducted this survey, from the professional perspective of medical workers, to explore the influence of COVID-19 on palliative care practice, and further put forward some interventions to deal with the status quo. Overall, this report not only identified specific aspects that have been negatively affected by COVID-19, but also underscored the need for useful coping strategies.

Although it is universally accepted that palliative care should be adopted by specialists in all oncology settings to benefit cancer patients and their families (17). The lack of integrating supportive care into comprehensive cancer treatment has become strikingly evident in the current context of the COVID-19 pandemic (18). In the present study, we found the majority of oncologists agreed that COVID-19 adversely impacted their routine clinical work (75.7%) and palliative care practice (64.9%) to a very large extent. Perhaps it is because this pandemic has created more uncertainty and disrupted the way that we practice medicine, including palliative and supportive cancer for cancer patients. Through ongoing international conversations pertaining to COVID-19, palliative care practitioners are asking whether we should attach more importance to patients with cancer, who are often the most vulnerable (19, 20). We consider that because of the underlying suppression of immune system and poor general condition heightening the risk for susceptibility to COVID-19 and relative complications, cancer

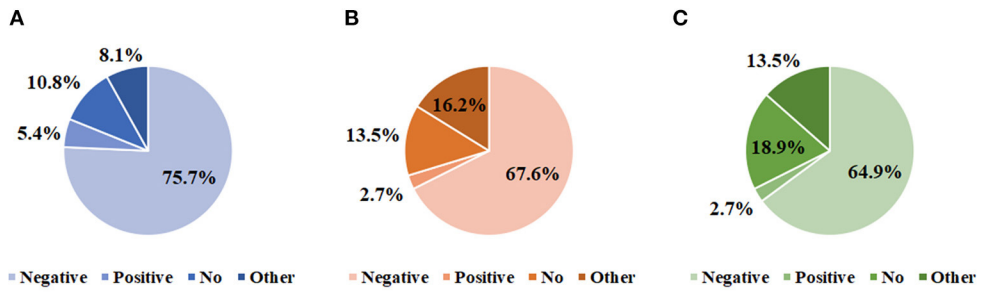


FIGURE 1
Experiences and perspective of oncologists regarding the impact of COVID-19. The extent to which COVID-19 affected clinical work routine in oncology **(A)**, personal daily lives **(B)**, and palliative care practice **(C)**.

**BOX 1 | Quotes per theme.**

*"Theme 1. Offering remote or online service"*
Offering more online guidance on palliative care for cancer patients and their families
*"Before the COVID-19 epidemic, there were more cancer patients from other provinces in our hospital, but due to the restrictions of the epidemic, the access and follow-up of these patients were very limited. Adding more online consultations may help them" #P25*
Promoting remote multidisciplinary cooperation
*"Multidisciplinary cooperation members cannot meet on-site due to epidemic restrictions, but the mechanism of online MDT (multidisciplinary treatment) is not mature enough and needs to be improved urgently" #P34*
*"Invite the professional palliative medicine team to join the multidisciplinary consultation" #P9*
Strengthening home-based palliative care
*"…palliative care at home for cancer patients should be given a higher priority, and access to remote medical guidance is less clear for physicians as well as patients" #P20*
*"The trend of shifting palliative care settings from hospital to home has been accelerated by COVID-19" #P37*
Using more modern technology in palliative care
*"…mobile phones and WeChat could become important tools to provide remote palliative care guidance during this COVID-19 period. It would be better to have some platforms like WeChat public account for telemedicine that do not involve doctors' personal privacy" #P32*
*Theme 2. Increasing the publicity, education, or shared decision-making for patients*
Encouraging shared decision-making
*"The situation of patients who need palliative care is often complex, especially end-of-life patients, and it could be more helpful and effective if patients and doctors share the decision-making process" #P35*
Increasing the publicity and education of palliative medicine
*"Increase palliative care education, positive publicity, and concept shaping, the actual potential demand in China is huge" #P19*
*Theme 3. More guidelines, training, or programs for care providers*
Standardizing palliative medicine training for medical workers
*"Palliative care providers working in different sites, different regions, and different fields will need more specialized training" #P11*
*"Most care providers actually do not specialize in this. They might lack relevant professional experience. More professional training in palliative medicine might be helpful" # P36*
Enhancing personalized palliative care programs
*"During COVID-19, government support may be more helpful, such as more palliative care programs and financial investments" #P5*
*"…promoting projects about personalized palliative care practices could be of great benefit, given that each doctor's situation (under the COVID-19 pandemic) is different" #P37*
Updating more information on COVID-19 in palliative care guidelines
*"The prevention and control of the COVID-19 in China is becoming more and more regular. Information and guidelines on palliative care also should be updated accordingly" #P35*

patients ought to be paid more attention and supports (21–24). Another concern is that palliative care practice to address certain circumstances of cancer patients remains inadequate and immature, such as in the particular case of the severe COVID-19 pandemic (25). Despite the fact that individuals with cancer on active palliative healthcare are more likely to require frequent hospital visits or meeting with professionals, the isolation of interpersonal contact and restrictions on patient access to hospitals, in order to reduce the risk of spreading SARS-CoV-2, bring great difficulties to the practice and promotion of palliative care (26). Hence, palliative care in oncology should be an explicit part of international response plans for COVID-19, especially considering the high morbidity and mortality from COVID-19 in patients with cancer (27).

More importantly, 67.6% oncologists in our study considered that their personal lives and daily routines also had been significantly and negatively affected by the COVID-19 outbreak. In a study from Italy during COVID-19, frontline

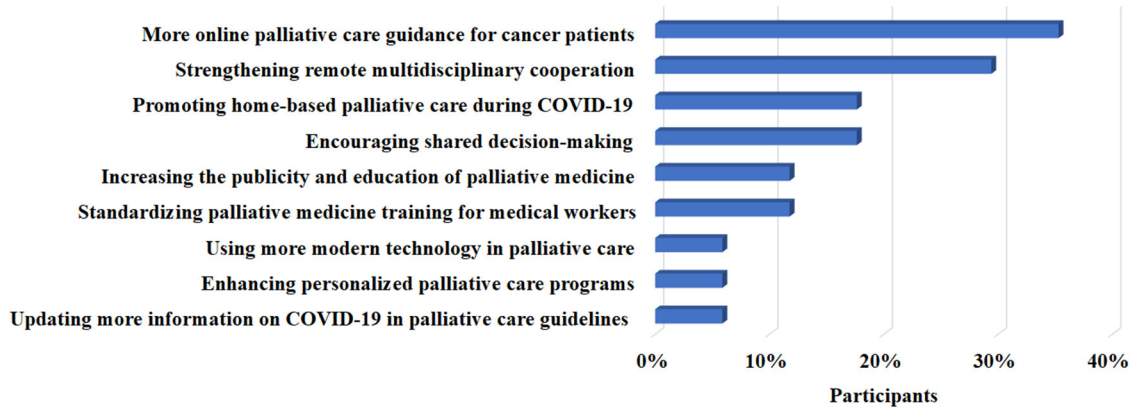


FIGURE 2
Personal suggestions on developing palliative care under the COVID-19 pandemic.

health care workers were reported severe posttraumatic stress symptoms, which could seriously affect their lives and careers (28). Previous studies also showed that medical workers tended to worry a lot about possibly infecting their families and thus usually were highly stressed even after coming back home (29, 30). Besides, numerous medical professionals around the world were sent to quarantine after contacting and fighting against COVID-19, which might cause a significant impact on the mental health and daily life of medical staff (31, 32). While patients are often the focus of attention during COVID-19, we believe that medical workers should be given full supports, appropriate comforts, and positive encouragements, as well, which may be one of the potential ways to motivate palliative care practitioners.

Furthermore, when it comes to the current status of the palliative care system in China, most specialists deemed that it remained underdeveloped. They also agreed that many other factors besides COVID-19 were associated with it, presumably on account of the unbalanced medical resources, conflicts of traditional values, and reluctance from patients (33–35). Thus, the development of palliative care still needs further efforts, not only in the current context of the pandemic but in the future. Despite challenges experienced during the pandemic, the global oncology community has responded with an unprecedented level of investigation and collaboration (36). This research also proposed some viable coping strategies, including promoting online palliative care guidance and home-based supportive care. Especially at present, the healthcare place is constantly shifting from the clinic to the home, where people can be treated *via* telehealth services, digital consultations, and intelligent devices (25, 37). These modern technologies are of great help and may encourage palliative care practice, even at the self-quarantine time during the COVID-19 outbreak. Similarly, based on digital equipment, remote multidisciplinary consultation and modern technology were also underlined by oncologists in this study. Emerging hi-technology will significantly contribute to palliative therapy if adopted properly and integrated into comprehensive care plan. However, novel technologies could augment traditional health strategies but cannot entirely replace them. As a result, shared decision-making, standardized palliative care training for medical workers, and personalized palliative medicine programs, etc., were also emphasized in this study.

Palliative care providers and hospice sectors play an essential role in the response to COVID-19 (38). Oncologists are known to provide supportive care with professional decisions, psychological counseling, and complex symptom management, especially for patients with advanced cancer (39). Providing such care is particularly challenging but also tremendously meaningful, given that humanitarian palliative caregivers with sufficient preparedness and capacity to cope with the current high-stress conditions of the COVID-19 pandemic may further improve the quality of life and optimize overall survival for cancer patients (35). Moreover, our study also highlighted that the issues and needs of palliative care practitioners should raise public concern and be further addressed.

There are several limitations. First, the sample size was moderate, but we have adopted some design strategies to improve response rates, including small financial incentives, mixed-mode survey, and brief questionnaire (40). In the current context of rapid spread of COVID-19, the opportunity to gather in-depth information was limited due to the extreme pressure on medical service system. Nonetheless, the results from our study supported a cross-sectional survey with larger sample to identify more examples of innovate practice in palliative care in the future. It also would be helpful to incorporate more diverse viewpoints from other palliative care participants in future research, such as nurses, as nurses

are also involved in palliative care and COVID-19 to a large extent. Second, using self-reported results may bias the conclusion, although this study focused primarily on the subjective feelings of the oncologist community. Finally, the dynamic state of pandemic and different medical backgrounds among countries may limit the generalizability of the results for other settings. In the future, larger-scale studies involving more countries and regions to examine the impact of COVID-19 on palliative care under different epidemic prevention policies are warranted.

## Conclusion

The COVID-19 pandemic has a significant adverse impact on palliative care practice, daily clinical routine, and personal lives, from the perspective of oncologists. Most of them consider the current palliative care system underdeveloped in China, and other factors besides COVID-19 may be associated with this situation. The corresponding measures should be taken to improve the clinical practice of palliative care during COVID-19, such as incorporating more online guidance and remote assistive technology in palliative care, encouraging home-based and personalized palliative care treatment according to the condition of patients, and promoting up-to-date information and practical training for palliative care practitioners.

## Data availability statement

The datasets presented in this article are not readily available because questionnaire data and interview transcripts are available upon reasonable request. Requests to access the datasets should be directed to YW, m13992895327@163.com.

## Ethics statement

This study was approved by the Ethics Committee of National Cancer Center/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College. Informed consent was obtained from all individual participants included in this survey.

## Author contributions

YW, DW, and XM acquired, analyzed, and interpreted all data. YW and YH drafted and revised the manuscript. XZ and NB reviewed and edited this manuscript critically. All authors contributed to the concept and design of this work and approved the final version to be published.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



## Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1020937/full#supplementary-material

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Muhammad Salman Shabbir,
Universiti Brunei Darussalam, Brunei

REVIEWED BY
Ingo Fietze,
Charité Universitätsmedizin
Berlin, Germany
Mihael H. Polymeropoulos,
Vanda Pharmaceuticals Inc.,
United States

*CORRESPONDENCE
Mark A. A. M. Leenders
mark.leenders@rmit.edu.au

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# Travel across time zones and the implications for human performance post pandemic: Insights from elite sport

Stephen C. Jasper, Mark A. A. M. Leenders* and Tim O'Shannassy

Graduate School of Business and Law, RMIT University, Melbourne, VIC, Australia

Notwithstanding technological innovation, the COVID-19 pandemic, and new communication tools, the need for travel is growing again and, in some travel segments, it is stronger than ever. Interestingly, the public health implications of traveling across time zones are still poorly understood and this is especially true for organizations that send their workers across the globe. Using data from 173 Olympic teams over 15 Olympic Games, we show that crossing multiple time zones has negative implications for human (sports) performance. More importantly, the results indicate that performance impairment is especially visible after flying east, with peak performance particularly impaired, leading to a "gold demotion effect" of gold medals to silver medals as a result. Given that Olympic sporting teams typically have dedicated medical staff and active mitigation strategies, these findings have important public health implications. For example, organizations are demanding their workers to be on "top of their game" while traveling, without providing them with the support and tools to do so. The implications for public health management and human resource management are discussed.

KEYWORDS

**RMIT classification, management, time zones, jet lag, public health, performance**

## Introduction

Globalization is an important driver for organizational growth and performance and to tap into opportunities for growth, organizations increasingly use global teams for innovation and market development. Notwithstanding the huge potential of employing global teams, there are organizational health risk factors that are poorly understood resulting in suboptimal outcomes from employees working across the globe and for public health in general (1).

Global organizational structures are increasingly facilitated through new technologies such as collaboration tools and video conferencing. This trend has seen tremendous growth as COVID-19 dramatically interrupted business travel and new ways of working using Zoom and other collaboration tools became part of the new normal (2). Although technology is facilitating new ways of communication and collaboration, team members continue to keep a significant travel schedule that is poorly

understood at the individual level, let alone at the organizational level in terms of stress, health and human impact (3).

The purpose of this article is to investigate an area where more is known about jet lag and impact and use this setting to further our understanding at the organizational and community level. In the area of global elite sport, much more is known about athletes, their travel schedules, health and their performance (4). This provides an interesting opportunity for interdisciplinary research to answer a question in global movement and management research that "has overlooked an important category of international operator: the international business traveler" (3).

This study is not about sports *per se*, but it uses a non-traditional assignment arena of athletes to inform studies on business travel and its impact on global team performance (5). Crossing multiple time zones can result in jet lag and sleep deprivation (6), which are likely to have adverse effects on performance (6, 7). Athletes—and there is anecdotal evidence a similar approach exists for employees—will try to mitigate the negative impact of travel by flying in early to allow adjustment, or by using some form of jet lag treatment plan (8, 9). Strategies to ameliorate the effects of jet lag include light seeking or avoidance, melatonin, and other pharmacological agents (8, 10). Compared to the support that athletes get, workers who travel get little or no support, even for travelers who traveled internationally as many as 26 times a year (11).

Little is still known about the extent of the impact and duration of jet lag, including social jet lag, on performance, although the rule of thumb is that recovering from jet lag takes "a number of days equal to about two-thirds of the number of time zones that have been crossed" (9) and the impact and duration of these effects vary across individuals and occasions (7, 12). The potential performance impairment for global teams that develop their market or develop new innovations is poorly understood. In addition, there may be an important need to support traveling workers better when they fly longer distances (1).

There is growing evidence that the symptoms of jet lag can worsen before resolving and that the direction of flight also has an impact (6). The circadian rhythm is a complex mechanism mediated by light, and jet lag is a disruption of this circadian rhythm (6). The symptoms of jet lag include insomnia and daytime sleepiness, but can also include "dysphoric mood, diminished physical performance, cognitive impairment, and gastrointestinal disturbances" (6), and even urticaria (13).

In this study, the aim is to use data on the travel and performance of Olympic national teams to understand the performance of international business travelers and the implications on international human resourcing and global work practices. Because the effects of jet lag can have a substantial impact on physical and cognitive ability (6), it is important to investigate these effects and their impact more closely. We present multi-year evidence of a measurable and significant adverse effect of crossing multiple time zones on Olympic team performance, with an emphasis on medal achievement composition. The results provide evidence of a "demotion effect" where athletes who were likely to win a gold medal win a silver medal instead. This "demotion effect" is studied while controlling for a range of other factors. The findings have implications for both athletes and business travelers and for organizations, including Australian businesses where business travel is prolific given the geographical location.

The structure is as follows; first, the factors influencing Olympic team performance are discussed, and the potential role and impact of jet lag on performance is explored. Second, three hypotheses are proposed on the relationship between the number of time zones crossed and the direction of flight on performance. Thirdly, the data set covering 15 Olympic Games and the methodology used to analyze this data is outlined; the results are presented and discussed; conclusions are drawn, and the implications and limitations are analyzed. Finally, the significance of the results for theory, management, organizations, and travel are discussed.

## Factors influencing Olympic performance

The Olympic games provide the context for our study on the impact of travel on human performance (4). To ensure the best performance outcomes, athletes need to be at their peak in terms of ability, training, support, and preparation. Several studies have identified determinants of Olympic success and a range of factors have previously been used to predict success in the Olympic Games.

The population size of the country is an obvious factor for Olympic medal success: nations with larger populations have an increased statistical probability of producing Olympic medal-winning athletes than nations with a smaller population to draw from. This positive relationship between population and medal count has been confirmed by Putt (14), who analyzed the correlation between population and weighted medal count (where gold, silver and bronze medals were weighted in a 3:2:1 ratio). Accordingly, almost every model used to predict Olympic medal count uses population as a basic factor to predict Olympic medal performance. A similarly intuitive measure for predicting Olympic medal success is the nation's gross domestic product (GDP) and its economic factors, as wealthier nations have more resources to direct to Olympic performance than less wealthy ones, and almost all predictive models take into account a nation's GDP *per capita*. Thus, a nation's population multiplied by its GDP *per capita* is the usual starting point for calculating Olympic medal success. Nations that have a strong sporting culture will show Olympic results above what would be expected for their population and GDP *per capita* (e.g., Bulgaria, North Korea). Often politics and national sport organizations are involved to win national esteem and to invest and support athletes' performance (15). Finally, there are some

Olympics specific factors such as the boost from hosting the Olympic Games and the strong positive effect on Olympic medal performance for the host nation is borne out of having a home advantage and incentives to invest (16). These necessary control factors will be included in our analyses.

## Time zone disparity and jet lag

Jet lag typically occurs when a person crosses three or more time zones (9), has a negative effect on performance (17), which extends to performance in sports (18). The effect is typically worse flying east than flying west [(19, 20), pp. 136, 138], and the degree of jet lag can be assessed with standardized scales to quantify this (7, 12, 21).

The effect of jet lag has been documented and studied considerably (18), and the negative impact of jet lag has been reported by athletes themselves; in a series of 15 interviews with Olympic athletes, jet lag was noted as a factor that negatively impacted performance (22). For an overview of Jet Lag studies see Table 1. As a result of this effect from jet lag, comprehensive and detailed jet lag management plans specifically for athletes have been devised, depending on the number of time zones crossed and the direction of flight (8), as the degree of jet lag is proportional to the number of time zones crossed (6).

The effects of crossing multiple time zones and the resultant jet lag have been assessed in a variety of sports, such as basketball (23). However, while the athletic community has been studied heavily, research into the effect of jet lag on international business travelers has been overlooked, with a lack of organizational support for business travelers despite them being a valuable resource to their company (3, 4). International business travelers are often "conducting business in a cloud of caffeinated jet lag" (17), despite the duty of care owed by companies to their employees (11).

## Olympic medal team performance

While travel time and mere distance may affect performance, this article makes the hypothesis that time zone disparity is an overlooked factor on athletic performance. Olympic medal tallies, in the Summer Olympics, are expected to be impacted in specific ways. As time zone disparity increases athletic performance is likely to be impacted (6). So there are a number of elements to the individual athlete's presentation for the personal examination presented by competition that are impacted adversely by time zone disparity, making high performance more difficult (1). Thus, it would seem highly likely that as the number of time zones crossed increases, the medal count decreases (i.e., human performance decreases).

***H1: There is a negative relationship between time zone disparity (the number of time zones crossed) and human sports performance.***

The direction of flight matters with respect to crossing time zones and performance. Typically, flying east results in more severe jet lag than flying an equivalent distance west [(20), pp. 136, 138]. This finding was borne out in a study of 20 healthy elderly subjects aged 67–87 years who had their circadian rhythm advanced or delayed, as alertness was disrupted more after the phase advance than after the phase delay (19). However, it has been noted that some people may respond better to flying eastward (18).

In a study that compared jet lag experienced by athletes flying west vs. flying east, the athletes who flew east took a longer time to adjust to the new time zone (24). Re-entrainment into the destination's time zone is more difficult if the circadian rhythm is contracted, which happens as a result of flying east, and is generally slower after flying east than it is after flying west (6, 25). Additionally, the direction of flight correlates with the type of jet lag experienced, with flying west associated with evening sleepiness and extremely early awakenings and flying east with difficulties falling asleep and morning or noontime sleepiness [(20), pp. 136, 138]. Even in the American National Football League with its limited time zone disparity of 3 h from the east to the west coasts of the United States, it was found west coast teams had an advantage in evening games (26). Similarly, in the American sports context eastward flight has been shown to negatively impact performance in baseball more than the equivalent westward flight (27).

Thus, it would seem reasonable to infer that performance will be more adversely affected, and therefore have a lower medal count in the Olympics setting, than those who fly west or remain in the same time zone, despite the preparation that teams will have made (1).

***H2: There is a more negative relationship between time zone disparity and human sports performance if the travel is in easterly direction.***

## Peak performance impact

Medical jet lag research has often focused on physical performance using objective biological markers such as vitamins or minerals (28); trace elements or biological variables such as nitric oxide (29). These indicators have been shown to have limited validity in terms of actual performance, with self-reported measures of physical performance being more useful than objective biological markers (30).

Human performance is not only dependent on physical attributes such as fine motor skills, gross motor performance but senses including eyesight, hearing, reflex response and cognitive function as well can all be important on the outcome depending on the sport (31). Thus, effective predictors of athletic performance include measures of physical and cognitive performance in preference to biological markers.

TABLE 1 Studies in jet lag.

| Study | Physical effect | Cognitive effect | Biological markers | Mood effect | Sleep effect | Sample size | Population studied |
|---|---|---|---|---|---|---|---|
| Arendt et al. (40) | No | ✓ | ✓ | ✓ | ✓ | 17 | Healthy volunteers |
| Arendt and Aldhous (41) | No | No | ✓ | No | No | 52 | Long-distance travelers |
| Becker et al. (7) | No | ✓ | ✓ | ✓ | ✓ | 89 | Long-distance travelers |
| Belcaro et al. (42)[a] (study 1) | No | ✓ | ✓ | ✓ | ✓ | 68 | Long-distance travelers |
| Belcaro et al. (42)[a] (study 2) | No | ✓ | ✓ | ✓ | ✓ | 65 | Long-distance travelers |
| Cho et al. (43) | No | ✓ | ✓ | No | No | 62 | Airline cabin crew |
| Claustrat et al. (44) | No | ✓ | No | ✓ | ✓ | 30 | Business travelers |
| Eastman et al. (45) | No | No | ✓ | No | ✓ | 26 | Healthy volunteers |
| Edwards et al. (46) | ✓ | ✓ | ✓ | No | ✓ | 31 | Business travelers |
| Fowler et al. (47) | ✓ | No | ✓ | ✓ | ✓ | 13 | Healthy male volunteers |
| Fowler et al. (48) | No | No | ✓ | No | ✓ | 18 | Athletes |
| Hill et al. (49)[b] (study 1) | ✓ | No | No | ✓ | ✓ | 7 | Athletes |
| Hill et al. (49)[b] (study 2) | ✓ | No | No | ✓ | No | 10 | Healthy volunteers |
| Hill et al. (49)[b] (study 3) | ✓ | No | No | No | No | 9 | Healthy volunteers |
| Jurvelin et al. (50) | No | No | No | ✓ | ✓ | 55 | Healthy volunteers |
| Katz et al. (51) | No | No | No | ✓ | No | 152 | Foreign tourists |
| Lahti et al. (52) | No | No | No | No | ✓ | 15 | Airline cabin crew |
| Lemmer et al. (24) | ✓ | No | ✓ | No | ✓ | 19 | Athletes |
| Monk et al. (19) | No | No | ✓ | No | ✓ | 20 | Healthy elderly volunteers |
| Nickelsen et al. (53) | No | No | ✓ | No | No | 36 | Long-distance travelers |
| Paul et al. (54)[b] (study 1) | ✓ | ✓ | ✓ | No | No | 14 | Healthy volunteers |
| Paul et al. (54)[b] (study 2) | ✓ | ✓ | ✓ | No | No | 13 | Healthy volunteers |
| Paul et al. (54)[b] (study 3) | ✓ | ✓ | ✓ | No | No | 10 | Healthy volunteers |
| Petrie et al. (55) | No | No | ✓ | ✓ | ✓ | 20 | Healthy volunteers |
| Petrie et al. (56) | No | No | ✓ | ✓ | ✓ | 52 | Airline cabin crew |
| Sasaki (25) | No | No | No | No | ✓ | 4 | Healthy volunteers |
| Spitzer et al. (21) | No | No | ✓ | ✓ | ✓ | 257 | Physicians |
| Suhner et al. (57) | No | No | No | ✓ | ✓ | 320 | Healthy volunteers |
| Suhner et al. (58) | No | No | ✓ | ✓ | ✓ | 137 | Healthy volunteers |
| Waterhouse et al. (59) | ✓ | No | No | ✓ | ✓ | 39 | Athletes and sport administrators |
| Waterhouse et al. (18) | No | No | ✓ | No | ✓ | 85 | Athletes |

[a]Belcaro et al. (42) and Zerbini et al. (60) include two studies.
[b]Hill et al. (49) and Paul et al. (54) each include three studies.

Peak performance has been shown to be closely aligned to the "flow" state described by Csikszentmihalyi (32). Given the disruption to cognitive function that can be caused by crossing multiple time zones and the resultant jet lag (6), it would seem reasonable to infer that the ability to attain peak performance could be impaired significantly by jet lag.

In order to obtain a gold medal, peak performance is paramount. The difference between gold and silver medals can be extraordinarily small; if a competitor traveled across more time zones than their competitors there may be a relatively small impairment of athletic performance, but it will result in a different medal. This small impairment may be very significant in terms of Olympic medal count: "at Athens, the combined margin of five British gold medals being silver medals was only 0.545 s—that shows how close it can be" (33). Thus, even the slightest effect on peak performance is likely to affect the gold medal count, demoting a competitor to silver or even bronze.

The small but significant deterioration in athletic peak performance may result in the competitor or team missing out on receiving a gold medal but receiving a silver medal or less instead. This "demotion effect" would be apparent if the mix of medals is downgraded. If only the highest levels of peak performance are affected, it is possible the lower medals (silver and bronze) may avoid this "demotion effect" and even get boosted instead.

TABLE 2 Descriptive statistics and Pearson correlation matrix.

| | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Time zone difference | 5.138 | 3.635 | 1 | | | | | | | | | | | |
| 2. easterly direction | 0.378 | 0.486 | 0.273*** | 1 | | | | | | | | | | |
| 3. Host? | 0.053 | 0.225 | −0.316*** | −0.185** | 1 | | | | | | | | | |
| 4. Host previous? | 0.053 | 0.225 | 0.141** | −0.087 | −0.056 | 1 | | | | | | | | |
| 5. Host following? | 0.053 | 0.225 | 0.128** | 0.109* | −0.056 | −0.056 | 1 | | | | | | | |
| 6. Distance (km) | 7,342.575 | 4,915.073 | 0.871*** | 0.250*** | −0.329*** | 0.133** | 0.092 | 1 | | | | | | |
| 7. Population (national) | 120 million | 260 million | 0.066 | −0.020 | 0.087 | 0.093 | 0.088 | 0.041 | 1 | | | | | |
| 8. GDP (national) | 1,491 billion | 27,161 billion | 0.060 | 0.019 | 0.052 | 0.123*** | 0.030 | 0.067 | 0.343*** | 1 | | | | |
| 9. Gold medals (total) | 10.941 | 12.173 | −0.029 | −0.069 | 0.327*** | 0.183*** | 0.087 | −0.021 | 0.456*** | 0.598*** | 1 | | | |
| 10. Silver medals (total) | 10.128 | 9.185 | −0.012 | −0.044 | 0.237*** | 0.173*** | 0.079 | −0.010 | 0.383*** | 0.602*** | 0.894*** | 1 | | |
| 11. Bronze medals (total) | 10.995 | 8.645 | −0.015 | −0.066 | 0.135** | 0.146** | 0.121** | 0.005 | 0.342*** | 0.605*** | 0.811*** | 0.835*** | 1 | |
| 12. Total medals | 32.064 | 28.468 | −0.021 | −0.064 | 0.257*** | 0.178*** | 0.100* | −0.011 | 0.422*** | 0.634*** | 0.962*** | 0.958*** | 0.920*** | 1 |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Several studies support the notion that peak performance may suffer most. For example, it is widely known that a person's chronotype affects the time during the day where performance peaks [(20), pp. 152–162]. For athletes, the variation in performance according to the time of day does have some endogenous input, most likely genetic (31).

***H3: There is a negative relationship between crossing time zones in easterly direction and human performance. This relationship is more negative for peak performance.***

For hypothesis 3 to hold the team's gold medal tally needs to show a "demotion effect" in gold medals (reflective of peak performance) and it may or may not show an increase in the tally of the lower medals (silver, bronze), depending on whether the performance impairment is more homogeneous across the performance curve. If there is a boost in silver medal count and not in bronze, it shows that silver medal count is less impaired then gold and also that silver "demotion" is not affecting the bronze medal tally significantly.

If there is support for (some of) the hypotheses in the highly performance managed arena of the Olympic Games, there are significant implications for the "amateurs" and unsupported team members in most organizations that have adopted global teams to compete better. The method, data and results will be presented next.

# Methodology

The data set covers 15 Olympic Games, starting with the Games of the XVII Olympiad held in Rome, 1960 until the Games of the XXXI Olympiad held in Rio de Janeiro, 2016. The Olympic Games held in 1960 was chosen as the start of the data set as jet airliners did not replace rail and ocean liners as the primary mode of long-distance travel until 1958 (16). Data were taken directly from the International Olympic Committee (IOC) website. For the purpose of comparability and control, only data from the Summer Olympics (as opposed to the Winter Olympics) were used. For data on populations and GDP, Google Public Data was used. Medals that were awarded and later revoked are not included in the data set. In terms of the sampled nations, only the 15 leading nations with stable borders were included. This approach makes sure that the countries are relatively similar but can still face significant different time zone challenges across different games.

## The dependent variables

The success on Olympic Games is measured in medals. Interestingly, there is additional detail in terms of the type of medal. *Gold medals (total)*: The number of gold medals won by a country. *Silver medals (total)*: The number of silver medals won by a country. *Bronze medals (total)*: The number of bronze medals won by a country. *Total medals*: The total number of medals won by a country.

## The independent variables

### Absolute time zone difference

For absolute time zone difference (ATZD), the difference of the time zone of the capital city of the competing nation and of the host city was used, according to the most direct route between the two cities. The maximum amount of time zone disparity that can occur is 12 h, and daylight saving is not taken into account due to the circadian rhythm being linked to "sun

time" [(20), pp. 152–162]. For example, athletes in Australia are taken as using the time zone of the capital city, Canberra (UT +10 h). For the 1984 Olympic Games in Los Angeles, the time zone of the host city is (UT −8 h); the time zone difference is not 18 h, but the absolute value of −6 = 6 h.

### Easterly direction

As discussed earlier, the direction of flight may have an impact on performance, with easterly travel likely to have more of an impact [(20), pp. 136, 138]. A dummy variable was used, where traveling east = 1, west or same time zone = 0.

### Population (national)

Population is used as a factor in almost all of the predictive models for Olympic performance and is included here. Data were taken from Google Public Data (34).

### GDP (national)

Nations with a high GDP are more likely to be able to direct resources to Olympic sports than nations with a low GDP. GDP data were taken from Google Public Data.

### Distance (km)

We used great-circle distance using Excel to measure distance between the capital city of the country and the host nation (35).

### Host nation

The potentially positive effect of being the host nation has been included as a factor, as it has with most other models predicting Olympic performance (15, 36–39). In the data, host nation = 1 and not host nation = 0.

### Host previously

Whether the country was hosting the previous Olympics was coded as a dummy, previous host nation = 1 and not previous host nation = 0 (37, 38).

### Host following

Hosting countries know many years before that they will host the Games and this may potentially affect preparation and support, so a measure is included regarding the host in the following 4 years, host nation next games = 1 and not host nation next games = 0 (37, 38).

## Results

The descriptive statistics and correlations for the variables are listed below in Table 2. The Pearson correlations show some interesting preliminary insights. The bivariate correlation between absolute time zone differences and medal performance is consistently negative, albeit often not significant for gold medal count ($r = -0.029$, $p = 0.17$), silver medal count ($r = -0.012$, $p = 0.22$), bronze medal count ($r = -0.015$, $p = 0.21$), and total medal count ($r = -0.021$, $p = 0.19$).Flying east seems to have a stronger negative effect for gold medal count ($r$ =0.069, $p = 0.08$), a close to significant correlation with silver count ($r = -0.044$, $p = 13$), and bronze medal count ($r = -0.066$, $p = 0.09$), and total medal count ($r = -0.064$, $p = 0.09$). Being a host is generally very supportive for medal wins and anticipation or past hosting seem to be positive as well. This is particularly true for gold medals ($r = 0.327$, $p < 0.001$). As expected, population size and GDP are significantly and positively correlated with medal counts of all colors.

The descriptive statistics show that the average number of time zones crossed in the sample is much higher (M = 5.14 time zones) than, for example studies, that study U.S. sporting teams traveling across the U.S. The odds of a team flying east are 37.8%. There is a 5.3% chance that country in the data sample hosts the Olympic Games. The average distance that a team travels is 7,342 km and given that China is in the sample, the average population is high (120 million). The average team in the sample won 10.9 gold medals, 10.1 silver medals, and 11.0 bronze medals (32 medals in total) *per* Olympic Games.

Table 3 shows the results from the multivariate moderated regression analysis for different team medal performance counts. All the key predictors of national team medal performance are included, including country dummies that can account for country heterogeneity (one country, the Netherlands, was taken as the baseline and omitted from the analysis as was the China dummy due to multicollinearity with population size). Where there is an interaction, the variables were first mean centered to reduce multicollinearity (61). Variance inflation factors are acceptable and around 1—and up to around 2 if distance in km—was included. In addition, we ran models with or without distance (km) and the results were similar.

The results in Table 4 show a similar picture to the correlation table. Generally, there is a negative relationship between (1) absolute time zone difference and performance and (2) flying east and performance. There is a notable negative relationship between crossing more time zones and gold medal tally ($b = -0.111$, $p = 0.06$). This shows that there is an impact from time zones in the expected direction that is not mitigated by athlete preparation or other counter measures (more on this when future research is discussed). So, while some individual athletes will be less affected than others, there is a measurable

TABLE 3 Multiple regression results for medal tallies.

| | Model 1 Bronze medal tally | | | Model 2 Bronze medal tally | | | Model 3 Silver medal tally | | | Model 4 Silver medal tally | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *β* | *t* | *p value* | *β* | *t* | *p value* | *β* | *t* | *p value* | *β* | *t* | *p value* |
| Constant | | 3.760 | <0.001*** | | 2.332 | 0.011** | | 3.051 | 0.002*** | | 1.902 | 0.030** |
| **Temporal factors** | | | | | | | | | | | | |
| Time zone difference | −0.067 | −0.794 | 0.215 | −0.071 | −0.837 | 0.202 | −0.020 | −0.250 | 0.402 | −0.010 | −0.122 | 0.452 |
| easterly direction | −0.053 | −1.308 | 0.097* | −0.045 | −1.053 | 0.147 | −0.021 | −0.536 | 0.297 | −0.044 | −1.090 | 0.139 |
| Time zone difference × easterly direction | – | – | – | −0.031 | −0.722 | 0.236 | – | – | – | 0.083 | 2.047 | 0.021** |
| **Location factors** | | | | | | | | | | | | |
| Host nation | 0.087 | 2.068 | 0.020** | 0.094 | 2.176 | 0.016** | 0.174 | 4.309 | <0.001*** | 0.155 | 3.765 | <0.001*** |
| Host previously? | 0.093 | 2.353 | 0.010** | 0.094 | 2.368 | 0.010** | 0.100 | 2.656 | 0.005*** | 0.098 | 2.629 | 0.009*** |
| Host following? | 0.105 | 2.665 | 0.004*** | 0.107 | 2.700 | 0.004** | 0.035 | 0.928 | 0.178 | 0.031 | 0.812 | 0.209 |
| Distance (km) | 0.049 | 0.555 | 0.290 | 0.048 | 0.535 | 0.297 | 0.027 | 0.321 | 0.375 | 0.032 | 0.379 | 0.353 |
| **Economic factors** | | | | | | | | | | | | |
| Population (national) | 0.226 | 4.548 | <0.001*** | 0.225 | 4.507 | <0.001*** | 0.259 | 5.446 | <0.001*** | 0.263 | 5.579 | <0.001*** |
| GDP (national) | 0.236 | 4.386 | <0.001*** | 0.230 | 4.239 | <0.001*** | 0.145 | 2.809 | 0.003*** | 0.159 | 3.090 | 0.001*** |
| **Country controls** | | | | | | | | | | | | |
| AUS | 0.150 | 2.661 | 0.005***. | 0.149 | 2.645 | 0.005*** | 0.124 | 2.296 | 0.012** | 0.125 | 2.352 | 0.010** |
| CAN | 0.031 | 0.616 | 0.270 | 0.026 | 0.508 | 0.306 | 0.000 | 0.002 | 0.499 | 0.014 | 0.288 | 0.387 |
| FRA | 0.138 | 2.722 | 0.004*** | 0.138 | 2.725 | 0.004*** | 0.082 | 1.698 | 0.046** | 0.081 | 1.694 | 0.046** |
| GER | 0.297 | 6.578 | <0.001*** | 0.300 | 6.606 | <0.001*** | 0.202 | 4.674 | <0.001*** | 0.194 | 4.517 | <0.001*** |
| GBR | 0.143 | 2.786 | 0.003*** | 0.137 | 2.631 | 0.005*** | 0.116 | 2.365 | 0.010** | 0.132 | 2.685 | 0.004*** |
| HUN | 0.103 | 2.051 | 0.021** | 0.104 | 2.054 | 0.021** | 0.089 | 1.833 | 0.035** | 0.088 | 1.834 | 0.034** |
| ITA | 0.101 | 1.995 | 0.024** | 0.101 | 1.984 | 0.025** | 0.054 | 1.105 | 0.136 | 0.055 | 1.137 | 0.129 |
| JPN | 0.062 | 1.211 | 0.114 | 0.061 | 1.180 | 0.120 | 0.002 | 0.046 | 0.482 | 0.006 | 0.127 | 0.450 |
| RUS | 0.422 | 9.857 | <0.001*** | 0.421 | 9.810 | <0.001*** | 0.331 | 8.083 | <0.001*** | 0.334 | 8.229 | <0.001*** |
| KOR | 0.017 | 0.331 | 0.371 | 0.014 | 0.282 | 0.390 | 0.019 | 0.400 | 0.345 | 0.026 | 0.539 | 0.295 |
| ESP | −0.095 | −1.869 | 0.032** | −0.096 | −1.880 | 0.031** | −0.042 | −0.849 | 0.199 | −0.040 | −0.816 | 0.208 |
| UKR | 0.104 | 2.390 | 0.009*** | 0.104 | 2.385 | 0.009*** | 0.018 | 0.436 | 0.332 | 0.018 | 0.446 | 0.328 |
| USA | 0.504 | 8.521 | <0.001*** | 0.502 | 8.460 | <0.001*** | 0.624 | 11.011 | <0.001*** | 0.630 | 11.207 | <0.001*** |
| N | 187 | | | 187 | | | 187 | | | 187 | | |
| *F* value | 25.627 | | | 24.415 | | | 28.687 | | | 28.099 | | |
| Sign. | <0.001*** | | | <0.001*** | | | <0.001*** | | | <0.001*** | | |
| $R^2$ | 0.764 | | | 0.765 | | | 0.784 | | | 0.789 | | |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

and negative relationship between flying across more time zones and gold tally, even after controlling for distance. With respect to the flying direction, there is a notable relationship between traveling east and the bronze tally ($b = -0.053$, $p = 0.10$). Interestingly, the overall tally also suffers from flying in an easterly direction all else equal ($b = -0.042$, $p = 0.10$).

In line with the consistent negative signs across all time zone and direction coefficients, it is fair to say that (1) time zones affect performance negatively, especially in the gold tally (H1 is supported for gold tally and not rejected for the other medal types given the consistent negative pattern in the data), and (2) flying in easterly direction affects performance negatively, especially for bronze and total medals (H2 is supported for bronze and total ($p$ <0.10) and not rejected for the other medal types because of the consistent negative pattern). In sum, evidence for H1 and H2 is mixed with only significant relationships for select medal metrics only. However, there is generally directional support across all medal metrics.

When the interaction between absolute time zone difference and flying east is included (61), it shows a significant negative coefficient for the interaction on silver medal count ($b = 0.083$, $p = 0.021$). This is not the case for gold, bronze and total medals. Generally, this result shows that there is a measurable weak

TABLE 4 Multiple regression results for medal tallies.

| | Model 5 Gold medal tally | | | Model 6 Gold medal tally | | | Model 7 Total medal tally | | | Model 8 Total medal tally | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *β* | *t* | *p value* | *β* | *t* | *p value* | *β* | *t* | *p value* | *β* | *t* | *p value* |
| Constant | | 1.901 | 0.030** | | 0.309 | 0.379 | | 0.621 | <0.001*** | | 1.834 | 0.034* |
| **Temporal factors** | | | | | | | | | | | | |
| Time zone difference | −0.111 | −1.577 | 0.059* | −0.110 | −1.560 | 0.061* | −0.074 | −1.155 | 0.125 | −0.072 | −1.112 | 0.134 |
| easterly direction | −0.030 | −0.884 | 0.189 | −0.032 | −0.890 | 0.188 | −0.036 | −1.151 | 0.126 | −0.041 | −1.272 | 0.103 |
| Time zone difference × easterly direction | – | – | – | 0.005 | 0.154 | 0.439 | – | – | – | 0.020 | −0.604 | 0.274 |
| **Location factors** | | | | | | | | | | | | |
| Host nation | 0.276 | 7.840 | <0.001*** | 0.275 | 7.573 | <0.001*** | 0.201 | 6.235 | <0.001*** | 0.196 | 5.918 | <0.001*** |
| Host previously? | 0.113 | 3.438 | <0.001*** | 0.113 | 3.423 | <0.001*** | 0.109 | 3.620 | <0.001*** | 0.109 | 3.597 | <0.001*** |
| Host following? | 0.046 | 1.408 | 0.081* | 0.046 | 1.392 | 0.083* | 0.063 | 2.095 | 0.019 | 0.062 | 2.051 | 0.021** |
| Distance (km) | 0.157 | 2.118 | 0.018** | 0.157 | 2.115 | 0.018** | 0.091 | 1.341 | 0.091 | 0.092 | 1.355 | 0.089 |
| **Economic factors** | | | | | | | | | | | | |
| Population (national) | | | <0.001*** | 0.313 | 7.523 | <0.001*** | 0.286 | 7.545 | <0.001*** | 0.287 | 7.549 | <0.001*** |
| GDP (national) | | | 0.018** | 0.096 | 2.113 | 0.018** | 0.159 | 3.875 | <0.001*** | 0.162 | 3.913 | <0.001*** |
| **Country controls** | | | | | | | | | | | | |
| AUS | 0.013 | 0.269 | 0.395 | 0.013 | 0.270 | 0.393 | 0.091 | 2.115 | 0.018 | 0.091 | 2.120 | 0.018** |
| CAN | −0.059 | −1.392 | 0.083* | −0.058 | −1.353 | 0.089* | −0.016 | −0.405 | 0.343 | −0.012 | −0.316 | 0.377 |
| FRA | 0.051 | 1.218 | 0.113 | 0.051 | 1.213 | 0.114 | 0.090 | 2.341 | 0.010 | 0.090 | 2.330 | 0.011** |
| GER | 0.179 | 4.747 | <0.001*** | 0.179 | 4.700 | <0.000*** | 0.232 | 6.731 | <0.001*** | 0.230 | 6.637 | <0.001*** |
| GBR | 0.067 | 1.576 | 0.059* | 0.069 | 1.575 | 0.059* | 0.110 | 2.804 | 0.003 | 0.114 | 2.859 | 0.003** |
| HUN | 0.090 | 2.129 | 0.018** | 0.090 | 2.121 | 0.018** | 0.098 | 2.554 | 0.006 | 0.098 | 2.545 | 0.006*** |
| ITA | 0.055 | 1.310 | 0.096* | 0.055 | 1.307 | 0.097* | 0.072 | 1.854 | 0.033 | 0.072 | 1.857 | 0.033** |
| JPN | 0.012 | 0.273 | 0.393 | 0.012 | 0.279 | 0.391 | 0.025 | 0.628 | 0.266 | 0.026 | 0.651 | 0.258 |
| RUS | 0.278 | 7.781 | <0.001*** | 0.278 | 7.758 | <0.001*** | 0.354 | 10.836 | <0.001*** | 0.355 | 10.830 | <0.001*** |
| KOR | 0.013 | 0.318 | 0.376 | 0.014 | 0.327 | 0.372 | 0.017 | 0.442 | 0.330 | 0.019 | 0.481 | 0.316 |
| ESP | −0.067 | −1.575 | 0.059* | −0.067 | −1.567 | 0.060* | −0.071 | −1.824 | 0.035 | −0.071 | −1.808 | 0.036* |
| UKR | 0.021 | 0.577 | 0.283 | 0.021 | 0.575 | 0.283 | 0.047 | 1.398 | 0.082 | 0.047 | 1.397 | 0.082* |
| USA | 0.612 | 12.388 | <0.001*** | 0.612 | 12.343 | <0.001*** | 0.616 | 13.645 | <0.001*** | 0.617 | 13.632 | <0.001*** |
| *N* | 187 | | | 187 | | | 188 | | | 187 | | |
| *F* value | 40.268 | | | 38.213 | | | 49.723 | | | 47.298 | | |
| Sign. | <0.001*** | | | <0.001*** | | | <0.001*** | | | <0.001*** | | |
| $R^2$ | 0.836 | | | 0.836 | | | 0.863 | | | 0.863 | | |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

negative relationship across the medals and that this pattern is visible after controlling for distance traveled, and country characteristics and hosting. Interestingly silver is behaving somewhat differently than gold and bronze.

The fact that the interaction between time zones and direction is significant for silver medals warrants a deeper investigation in the nature of the interaction between crossing time zones and flight direction. First, Figure 1 shows the two *in*significant interactions (Gold and Bronze tally) indicating that large time zone differences are negative for performance and that the *slopes* are not statistically different for flying in an easterly or westerly direction (i.e., no significant acceleration downwards associated with direction although the slope is slightly more negative for the gold and bronze tally when flying in an easterly direction). There is generally a negative effect from flying in an easterly direction as discussed, and H2 is supported for gold and bronze. Second, the pattern is different for silver medals (Figure 2). For silver, the similar slopes are *not* similar, and a crossover emerges with for small time zone disparity a decrease in medal tally, but for high time zone disparity an increase in silver tally emerging. The increase in silver medal kicks in when the team both crosses multiple time zones *and* crosses them in an easterly direction. One explanation is that the gold medal count is demoted as the time zones crossed in easterly direction take

their toll on gold medal performance more than on silver medal performance. If the silver medal count was affected equally, the bronze medal count would benefit in the same way, which is not the case, and the bronze pattern is basically negative as can be expected from crossing more time zones in easterly direction. This supports H3.

In sum, the slopes in Figures 1, 2 are generally negative, which is what can be expected from what is known about performance impairment from jet lag and easterly flight direction. However, the silver medal counts are impacted somewhat differently. At first glance, the silver tally seems to slightly benefit from crossing more time zones and doing so in easterly direction (=worst jet lag situation!). Although this may seem strange, this can be explained by peak performance impairment resulting in a boost to silver medal counts from decreased gold medal counts which are diminished more when athletes cross multiple time zones flying eastwards. Interestingly, the silver tally is lower in the low jet lag region of the graph (left hand side of Figure 2) if the flight direction is eastwards (the dotted line in Figure 2). In other words, performance impairment is not homogenous across the performance curve, and peak performers seem to struggle most from crossing multiple time zones, and the resultant jet lag, and flight direction. H3 is supported. To the best of our knowledge, this is the first study that theorizes on and finds empirical proof of the "gold demotion" effect that Olympic teams face, even with all the preparation and investments.

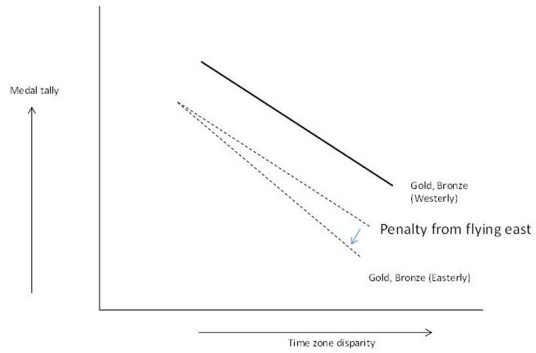


FIGURE 1
Gold and Bronze medal pattern.

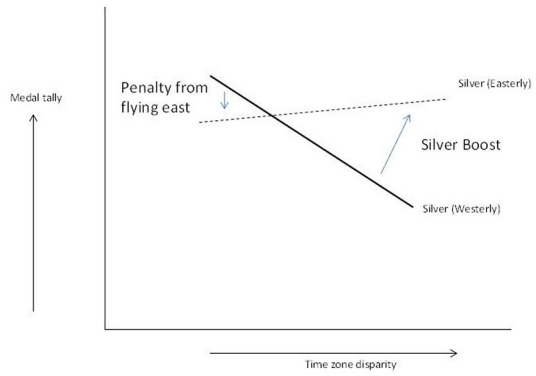


FIGURE 2
Silver medal pattern.

## Discussion

The basic assumption of this study is that organizations and employee performance management can learn from Olympic teams when it comes to travel, stress and health, and performance.

Olympic teams from well-resourced nations benefit from well-informed sports science and invest significant funds in the education and training of athletes in managing jet lag and other adverse health impacts from long distance travel. The management literature is calling for similar training and education programs for professional managers to enhance job performance and employee wellness (4). By studying the medal outcomes of Olympic teams, we can better understand the human experience and performance outcomes and then use this insight to inform future management practice (1).

The key findings of the study are that traveling across multiple time zones is indeed negative for performance and that flying east is particularly challenging for people. In the first instance, these findings are related to athletes because that is where the data comes from. Even for a highly performance managed setting as Olympic games, these effects are significant. As the number of time zones crossed increases, the negative effect on performance increases, in line with studies (9).

Flying eastwards increases the negative performance effect, as it is generally more difficult to adjust after a long-distance flight eastwards than it is to adjust to the equivalent long distance flight westwards (9, 24). This negative effect on performance is particularly visible in peak performance areas, namely gold medalists, where there is a "demotion effect" creating an unexpected boost to silver medals when athletes cross more time zones in easterly direction.

It is fair to presume that for the "amateurs" and unsupported team members in most organizations that have adopted global teams, these effects may be much larger. At the bare minimum, this study is highlighting a potential issue in management that is not receiving enough attention.

## Managerial implications

This study has significant implication for people traveling internationally and for scholars interested at public health in general. Athletes are well-informed about arriving early, the role

of daylight, and therapeutic options to regulate the circadian rhythm but the stress and health effects seem material, even after some time. An interesting observation was a *positive* association between silver medal tallies and jet lag, indicating a "demotion effect," where athletes who would have otherwise won a gold medal came second. Being on the top of your game when jet lagged seems to be a key challenge. In addition, this may signal that there may be a larger public health problem in society at large that we are not understanding sufficiently. This will become more important as society opens up after the pandemic.

The implications for public health and management are significant, especially for high-performing individuals that need to bring their "A-game." Managers and humans in general need to consider the potential adverse effects of crossing multiple time zones, with preparations such as arriving to the venue early and auctioning a detailed plan for overcoming jet lag in organizations [e.g., (8)]. This requires focused education and training of the human resource to ensure peak performance and good health (1). Substantial amounts of business travel result in a significant amount of stress (62), and the resultant sleep deficit can cause significant cognitive and physical impairment (17) creating public health concerns.

## Limitations and future research

This study has some important limitations that offer opportunities for future research. Firstly, while we included data from 15 Olympic Games, future research can increase the sample size, include Winter Games and also include smaller nations. Secondly, future research is needed at the individual level with more details on the individual, his or her preparation, their engagement with jetlag management, and the timing during the day of the event. Thirdly, the role of chronotype could be studied in more detail and if additional data on preparation becomes available, more managerial insights can be obtained on what regimes help mitigate the impact on human sports performance. The time of day will have an impact as well for specific individuals. Overall, our study is still relevant as many of these factors should be averaged out by the large numbers of athletes participating in our study. Fourthly, while it is known that flying east has more negative effects than flying west on performance, the underlying mechanisms are poorly understood. While jet lag typically occurs after crossing three or more time zones (9), the more time zones crossed, the greater the extent of jet lag but the impact on the nature of the impairment and its duration is poorly understood and needs more research as well.

## 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

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

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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EDITED BY
Kun-Shan Wu,
Tamkang University, Taiwan

REVIEWED BY
Jie Luo,
Guizhou Normal University, China
Eric Klopp,
Saarland University, Germany
Zeinab Zaremohzzabieh,
Universiti Putra Malaysia, Malaysia

*CORRESPONDENCE
Binghai Sun
jky18@zjnu.cn
Weijian Li
xlxh@zjnu.cn

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# The relationship between teacher professional identity and burnout amid the pandemic: A moderated mediation model

Yishan Lin[1,2,3,4], Moses A. Ameyaw[1,2,3,4], Qinhan Zhang[1], Binghai Sun[1,2,3,4]* and Weijian Li[1,2,3,4]*

[1]College of Teacher Education, Zhejiang Normal University, Jinhua, China, [2]College of Psychology, Zhejiang Normal University, Jinhua, China, [3]Research Center of Tin Ka Ping Moral Education, Zhejiang Normal University, Jinhua, China, [4]Key Laboratory of Intelligent Education Technology and Application of Zhejiang Province, Zhejiang Normal University, Jinhua, China

**Background:** Teacher burnout is affected by personal and social factors. COVID-19 has greatly impacted teachers' physical and mental health, which could aggravate teacher burnout.

**Purpose:** Based on the JD-R model, this study aims to investigate the relationship between teacher professional identity (TPI) and job burnout during the COVID-19 pandemic, and examine the moderating roles of perceived organizational support (POS) and psychological resilience (PR) in these relationships among primary and secondary school teachers in China.

**Methods:** A total of 3,147 primary and secondary school teachers participated in this study.

**Findings:** Work engagement played a mediating role in the relationship between professional identity and burnout; when the POS and PR scores were high, the predictive coefficient of TPI on burnout was the largest.

**Originality:** This study tested the mechanism underlying the relationship between TPI and burnout, and explored the protective factors of burnout.

**Implications:** This study supports the applicability of the JD-R model during COVID-19 and provides ideas for teachers to reduce burnout.

KEYWORDS

**perceived organizational support, professional identity, psychological resilience, teacher burnout, work engagement**

## Introduction

Burnout refers to emotional exhaustion, a low sense of achievement, and a depersonalized state of psychological stress caused by an individual's inability to cope effectively with work pressure in their occupational field (1, 2). This phenomenon often occurs in many helping professions, such as doctors (3), policers (4), and teachers (5). Compared to university teachers, teacher burnout is more serious among primary and secondary school teachers in China (6) because they face increased pressure from students' academic achievements and teachers' titles. This phenomenon of teacher burnout among primary and secondary school teachers in China became more serious after the COVID-19 outbreak (7, 8). A study conducted by Sokal et al. indicated

that teachers were increasingly exhausted during the pandemic (7). With the outbreak of COVID-19, schools switched from traditional offline teaching to online teaching, which resulted in many difficulties for teachers, such as a lack of classroom management, a decline in the quality of teaching content, and difficulty in tracking teaching results (9–11). Furthermore, teachers would face pressure from family (e.g., work-family conflict) because they need to stay home during most of the pandemic, which would aggravate the conflict between work and family, all of which would increase teachers' workload during the COVID-19 pandemic, finally leading to serious burnout (12). Teacher burnout not only affects students' motivation (13) and academic achievement (14) but also has a negative effect on teachers' mental health [e.g., depression, (15)]. Considering the serious burnout teachers face during the COVID-19 pandemic and the negative consequences of burnout, it is necessary to explore the protective factors of teacher burnout, its underlying mechanisms, and moderating factors.

# Literature review

## Teacher professional identity and burnout

Teacher professional identity (TPI) is defined as the beliefs, values, and commitments that an individual holds toward being a teacher (16, 17). Some studies have found that TPI is not only an important indicator for measuring the quality of teachers' work, but also helps to promote teachers' job satisfaction, motivation, and work commitment (18). Some studies found that burnout was negatively affected by professional identity (PI) among some service professions (19–22). For example, Chen et al. found that during the COVID-19 pandemic, the PI of college teachers was an essential factor affecting burnout (19). Social identity theory (SIT) can explain why PI affects burnout, which posits that individuals in society actively compare themselves with groups similar to their own (social comparison) to confirm whether they have received due recognition and respect in the group. Most studies that have been conducted on SIT in the workplace believe that occupational identity is a manifestation of social identity in the workplace, which means that occupational identity is part of social identity. Some scholars have proposed that PI refers to the attitudes, values, knowledge, beliefs, and skills that are shared with others within a professional group, and can affect how people interact, compare, and differentiate themselves from other professional groups in the workplace (23). From the perspective of social identity, PI is a collective concept constructed by individuals' sense of belonging, values, recognition, and acceptance of their groups, which emphasizes the decisive role of objective factors in PI (24). When an individual perceives that society's recognition of their career is not in line with their set expectations, the individual will often seek to change their occupational status (25, 26). Based on this theory, we might conclude that, if an individual does not recognize their career, they might generate turnover intention. Thus, this study posits that teachers' PI is negatively associated with teacher burnout.

## The mediating role of work engagement

Work engagement (WE) is a positive, well-rounded, work-related emotional state characterized by energy, dedication, and focus (27). Research has shown that PI is positively correlated with WE (28–30). Other researchers have found a significant correlation between a single dimension of PI and WE (31). For example, the research conducted by Wang et al. found that PI was positively correlated with work engagement among hotel employees (30).

Regarding the relationship between PI and burnout, some researchers believe that WE is an independent concept that is negatively associated with burnout. It involves the way a person devotes more time and energy to complete their tasks (32, 33). The Job Demand-Resource (JD-R) model emphasizes that WE and burnout are two different psychological states induced by job demands and resources at work. Job demands can lead to psychological energy consumption, which ultimately leads to negative results such as burnout. Job resources are predictors of the motivational processes that can promote WE. Other researchers, using empirical research, have found that WE and burnout were negatively correlated (34–36). For example, Hultell and Gustavsson found that job demand and resources were predictors of WE and burnout; job demand positively predicted burnout, while job resources positively predicted WE (35). Theoretical and empirical research has found that TPI may buffer teachers' burnout through WE. Therefore, this study suggests that WE mediates the relationship between TPI and burnout (H1).

## The moderating role of perceived organizational support

Perceived Organizational Support (POS) refers to whether individuals feel that the organization values their contributions, whether individuals are content with the attention they provide to the organization, and whether the organization, in this case, schools, cares about the basic interests of employees (37). Organizational support theory (OST) suggests that teachers' perceptions of organizations depend on how much the organization values them (37, 38). Teachers are more dedicated, loyal, and responsive when they feel that the organization genuinely cares about their welfare and needs (39). It can be seen that POS is a positive attitude toward the profession.

No previous study has examined the relationship between TPI, POS, and WE. However, Social Exchange Theory (SET) can

provide a perspective. SET suggests that employees are willing to provide their best (e.g., positive attitudes and hard work) to their organization when they receive corresponding respect from the organization (40). Furthermore, studies have shown that POS is positively correlated with PI (41–43) and can improve teachers' work satisfaction (44, 45). POS reduces the negative effect of strain on WE (46). Therefore, POS may enhance the positive effects of PI on WE. Therefore, this study proposes that POS plays a moderating role in TPI and WE (H2).

## The moderating role of psychological resilience

Psychological resilience (PR) is an individual's ability to bounce back in the face of adversity, trauma, tragedy, or stress. It is a vital personal psychological resource in today's fast-paced, high-stress, and unpredictable work environment (47). Previous studies have shown that WE is positively correlated with PR (48–50). Lyu et al. found that during the COVID-19 pandemic, both the PR and organizational identity of medical staff positively impacted WE (49). Clark et al. argued that the higher the PR of medical staff, the higher their WE. According to the JD-R model, job engagement is negatively related to burnout; PR is a psychological resource that can alleviate negative psychological problems caused by work (51). Liu et al. found that during the COVID-19 pandemic, the PR of high school teachers had a significant negative predictive effect on burnout and turnover intention (52). Teachers with high PR will have better interpersonal relationships, a more satisfying sense of job competence and work efficiency, and can alleviate burnout. Therefore, this study posits that PR might play a moderating role in the relationship between WE and burnout (H3).

Previous studies have shown that teachers' PI, WE, POS, and PR have positive effects on preventing or reducing the level of teacher burnout (53–55). However, these studies generally examined the impact of a single factor on teacher burnout, ignoring the interaction effect of several variables on burnout. Variables interact with each other; that is, the function of the variables is conditional. Thus, it is necessary to explore the interaction effects of these variables. Furthermore, most previous research has discussed the influence of certain independent variables on teacher burnout (56, 57), but few have discussed their mediating mechanisms. Understanding the underlying mechanisms of teacher burnout is important for researchers to design interventions to prevent burnout. Therefore, it is necessary to explore the mediating mechanisms of teacher burnout.

## Theoretical basis

The JD-R model could be the theoretical basis of this study to explain teacher burnout. The JD-R model mainly assumes that job burnout is caused by an imbalance between job demands and resources and that many job resources can compensate for the impact of high job demands on job burnout (58). Job resources can be divided into four categories: material, conditional, personal, and energy-based resources (59). In particular, TPI and PR could be regarded as resources of personal character that could be used to help individuals resist stress, whereas POS could be regarded as conditional resources obtained from the external environment (59). WE and burnout are closely related and fundamentally different concepts (27). Research has shown that WE plays a mediating role in the relationship between job resources and burnout (60), and POS and PR play moderating roles in these relationships (46, 52). Based on the theoretical basis and empirical evidence, this study proposes a theoretical model.

Based on the JD-R model theory, we propose a theoretical model. We expect that our results will not only support this theory but also extend it. The JD-R model posits that resources could help individuals prevent or reduce their level of burnout. Resources can be divided into personal, organizational, and other resources. Although the JD-R model posits that resources are significant for preventing burnout, it does not consider the effects of different levels of resources (e.g., personal and organizational resources), especially when they interact with one another. In our study, we considered the effects of personal resources (i.e., TPI and PR) and organizational resources (i.e., POS), which might differ from those of previous studies.

## Research questions

In summary, this study aimed to explore the mechanisms underlying the relationship between TPI and burnout. Based on these theories and empirical evidence, we propose the following hypotheses:

*Hypothesis 1*: WE mediates the relationship between TPI and burnout.
*Hypothesis 2*: POS moderates the relationship between TPI and work engagement.
*Hypothesis 3*: PR moderates the relationship between WE and teacher burnout.

The model is shown in Figure 1.

# Methods and materials

## Sample

This study was approved by the Ethics Committee of Zhejiang Normal University and performed in accordance with the Declaration of Helsinki and APA ethical standards. The survey was conducted over 3 months, from June to September

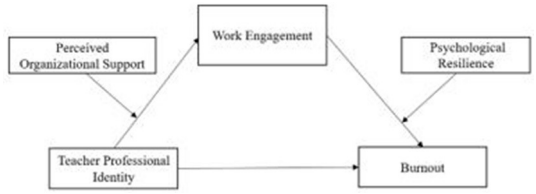


FIGURE 1
Hypothesized model of processes linking teacher professional identity and burnout, mediated by work engagement and moderated by perceived organizational support and psychological resilience.

2021. Simple sampling was used, and 3,500 in-service teachers in a city in Zhejiang Province participated in this study. After excluding 353 questionnaires with incomplete responses, 3,147 valid questionnaires were included. There were 927 females and 2,220 males, with an average age of 39 years and a standard deviation of 8.74 years old. The average number of years of teaching was 17.90 years. Among the 3,147 valid questionnaires, 2,040 (64.82%) were pre-and primary school teachers, and 1,107 (35.18%) were secondary school teachers. A total of 2,856 (90.75%) teachers majored in teaching, and 291 (9.25%) majored in a non-teaching program.

## Measures

### Burnout

Teacher burnout was measured using the Professional Quality of Life Scale designed by Stamm (61). This scale has three dimensions: burnout, compassion satisfaction, and secondary traumatic stress. The burnout subscale includes eight items. A five-point Likert scale (1 = never, 5 = very often) was used to ascertain participants' opinions. The higher the score, the stronger the burnout. In this study, Cronbach's alpha coefficient of the scale was 0.90.

### Teacher professional identity

TPI was assessed using the Teachers' Professional Identity Scale by Wei et al. (62). The scale comprises four dimensions, namely, occupational values, role values, sense of occupational belonging, and professional behavior inclination, and eighteen items. All items are scored on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). In this study, Cronbach's alpha coefficient of the scale was 0.94.

### Work engagement

WE was measured using the Utrecht Work Engagement Scale (UWES) by Schaufeli and Bakker (63), which consists of three dimensions: vigor, dedication, and absorption. The scale consists of nine items, and each item is scored on a five-point Likert scale (1 = never, 5 = always). In this study, Cronbach's alpha coefficient of the scale was 0.94.

### Perceived organizational support

POS was measured using the Perceived Organizational Support Scale designed by Eisenberger et al. (64). The scale consists of nine items, and each item was scored according to a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). In this study, Cronbach's alpha coefficient of the scale was 0.91.

### Psychological resilience

PR was assessed using the Psychological Capital Questionnaire designed by Zhang (65) for primary and secondary school teachers. The scale has nineteen items and four dimensions: resilience, self-confidence, hope, and optimism. A six-point Likert scale was used (1 = strongly disagree, 6 = strongly agree). In this study, Cronbach's alpha coefficient of the scale was 0.82.

# Procedures and data analysis

The data were collected electronically. First, a link to the questionnaire was sent to all participants *via* the Credamo platform. Second, the data were collated, and finally imported and analyzed using SPSS 21.0 (66). The data were analyzed as follows.

(1) Descriptive statistics and correlation analyses were performed on the main variables. (2) The SPSS PROCESS macro was used for mediation and moderation analysis with 5,000 bootstrapped samples. (3) Model 4 (PROCESS macro) was used to examine the mediating effect of job engagement between teachers' PI and job burnout. (4) Model 1 was used to examine the moderating effects of POS and resilience on teachers' PI and job engagement, as well as job engagement and burnout. (5) Model 21 was used to moderate the mediation analysis. A 95% CI was reported in our study. The CI in the Results section represents the 95% CI.

# Results

## Results of common method bias

Since the data collected by the questionnaire in this study were all from teachers' self-reports, there may be common methodological deviations. In this study, the Harman single-factor test was used as a statistical control. The results showed that the eigenvalues of 14 factors were >1, and the explanatory

TABLE 1 Means, standard deviations, and bivariate correlations among variables.

| Variables | *M* | SD | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| TPI | 4.50 | 0.49 | – | | | |
| WE | 3.90 | 0.78 | 0.63** | – | | |
| BO | 2.16 | 0.69 | −0.55** | −0.67** | – | |
| POS | 3.81 | 0.84 | 0.50** | 0.53** | −0.58** | – |
| PR | 4.90 | 0.79 | 0.59** | 0.68** | −0.66** | 0.51** |

TPI, teacher professional identity; WE, work engagement; BO, burnout; POS, perceived organizational support; PR, psychological resilience.
**$p < 0.01$.

power of the first factor was 37.41%, which was less than the critical value of 40%, indicating that there were no serious problems resulting from common method bias in this study.

## Descriptive statistics and correlational analyses

The descriptive statistics are presented in Table 1. The results of correlational analyses showed that burnout was negatively correlated with TPI ($r = -0.55$, $p < 0.01$), WE ($r = -0.67$, $p < 0.01$), POS ($r = -0.58$, $p < 0.01$), and PR ($r = -0.66$, $p < 0.01$). TPI was positively related to WE ($r = 0.63$, $p < 0.01$), POS ($r = 0.50$, $p < 0.01$), and PR ($r = 0.59$, $p < 0.01$). Furthermore, the results found that WE was positively correlated with POS ($r = 0.53$, $p < 0.01$) and PR ($r = 0.68$, $p < 0.01$). These results indicate that TPI, WE, POS, and PR may be regarded as protective factors in reducing the level of burnout. The results are shown in Table 1.

## Results of moderation effect of POS and PR

The results of the moderation effects of POS and PR after controlling for gender and age are shown in Table 2. Regarding the moderating role of POS, the results found that there was an interaction effect of TPI and POS on WE, indicating that POS played a moderating role in the relationship between TPI and WE [$B = 0.06$, $SE = 0.03$, CI = (0.01, 0.10), $p < 0.05$]. Further simple slope analysis showed that compared to the low POS (M-1SD), the predictive coefficient of TPI on WE increased from 0.74 [$SE = 0.03$, CI = (0.69, 0.79)] to 0.83 [$SE = 0.03$, CI = (0.75, 0.91)] when the POS score was high (M + 1 SD). As for the moderating role of PR, the results showed a significant interaction effect of WE and PR on burnout [$B = -0.01$, $SE = 0.00$, CI = (−0.01, 0.00), $p < 0.05$]. Further simple slope analysis showed that compared to the low PR (M – 1 SD), the predictive coefficient of WE on burnout increased from 0.34 [$SE = 0.02$, CI = (−0.37, −0.31)] to 0.41 [$SE = 0.02$, CI = (−0.44, −0.37)] when the PR score was high (M + 1 SD).

## Results of moderated mediation analysis

The results of the moderated mediation analysis, after controlling for gender and age, are shown in Table 3. The results showed that WE played a partial mediating role in the relationship between TPI and burnout [X-M: B = 0.78, CI = (0.73, 0.83), $p < 0.001$; M-Y: B = −0.33, CI = (−0.36, −0.30), $p < 0.001$; X-Y: B = −0.16, CI = (−0.20, −0.11), $p < 0.001$]. The results showed that POS played a moderating role in the relationship between TPI and WE, and PR played a moderating role in the relationship between WE and burnout. Further simple slope analysis showed that when the scores of POS and PR were high, the predictive coefficient of TPI on burnout through WE was −0.31; when the scores of POS and PR were low, the predictive coefficient of TPI on burnout was −0.22. This result indicated that when the POS and PR scores were high, the predictive effect of TPI on burnout through WE was the largest. The direct effect of TPI on burnout was −0.19. Thus, the indirect effect of WE accounted for 62.0% of the total effect.

# Discussion

Based on the JD-R model, this study explored the mediating role of WE in the relationship between TPI and burnout among Chinese primary and secondary school teachers and examined the moderating roles of POS and PR. This study reveals that when POS and PR are high, the predictive effect of TPI on burnout is greatest through WE. On the one hand, the organizational level should strengthen the affirmation of teachers' work so that teachers have a more positive attitude toward their work. On the other hand, it is necessary to provide full support to teachers to increase their positive psychological emotions, thereby reducing job burnout caused by long-term online teaching.

## The mediating role of WE between POS and burnout

According to the Pearson correlation results, the correlation between the three variables was significant at the 0.01 level. Specifically, the correlation coefficient between burnout and TPI was −0.55, that between burnout and WE was −0.67, and that between TPI and WE was 0.63. This result is consistent with previous research findings, that is, TPI had a negative effect on burnout (67), WE had a negative predictive effect on burnout (33), and TPI had a significant positive effect on WE (28).

TABLE 2 Results of the moderation analyses.

| | Y: WE | | | | | Y: BO | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ***B*** | **SE** | **95% CI** | | | ***B*** | **SE** | **95% CI** | |
| X: TPI | 0.78*** | 0.03 | 0.73 | 0.83 | X: WE | −0.37*** | 0.01 | −0.40 | −0.35 |
| M: POS | 0.29*** | 0.01 | 0.26 | 0.31 | M: PR | −0.06*** | 0.00 | −0.06 | −0.05 |
| X × M | 0.06* | 0.03 | 0.01 | 0.10 | X × M | −0.01** | 0.00 | −0.01 | 0.00 |
| Gender | 0.15*** | 0.02 | 0.11 | 0.20 | Gender | 0.08** | 0.02 | 0.04 | 0.12 |
| Age | 0.01*** | 0.00 | 0.01 | 0.01 | Age | 0.01*** | 0.00 | 0.00 | 0.01 |
| Constant | 3.42*** | 0.05 | 3.32 | 3.51 | Constant | 1.89*** | 0.04 | 1.81 | 1.97 |
| | | | $R^2 = 0.49$ | | | | | $R^2 = 0.54$ | |
| | | | $F_{(5, 3,141)} = 602.58^{***}$ | | | | | $F_{(5, 3,141)} = 739.64^{***}$ | |
| | **Conditional effect of X on Y** | | | | | **Conditional effect of X on Y** | | | |
| | ***B*** | **SE** | **95% CI** | | | ***B*** | **SE** | **95% CI** | |
| M: M − 1 SD | 0.74*** | 0.03 | 0.69 | 0.79 | M: M − 1 SD | −0.34*** | 0.02 | −0.37 | −0.31 |
| M: M + 1 SD | 0.83*** | 0.04 | 0.75 | 0.91 | M: M + 1 SD | −0.41*** | 0.02 | −0.44 | −0.37 |

CI, confidence interval; TPI, teacher professional identity; POS, perceived organizational support; WE, work engagement; PR, psychological resilience; BO, burnout.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

TABLE 3 Results of the moderated mediation analysis.

| | M: WE | | | Y: BO | | |
|---|---|---|---|---|---|---|
| | ***B*** | **SE** | **95% CI** | ***B*** | **SE** | **95% CI** |
| X: TPI | 0.78*** | 0.03 | 0.73, 0.83 | −0.16*** | 0.02 | −0.20, −0.11 |
| W: POS | 0.29*** | 0.01 | 0.26, 0.31 | – | – | – |
| X × W | 0.06* | 0.03 | 0.01, 0.10 | – | – | – |
| M: WE | – | – | – | −0.33*** | 0.02 | −0.36, −0.30 |
| V: PR | – | – | – | −0.05*** | 0.00 | −0.06, −0.05 |
| M × V | – | – | – | −0.01*** | 0.00 | −0.01, 0.00 |
| Gender | 0.15*** | 0.02 | 0.11, 0.20 | | | |
| Age | 0.01 | 0.00 | 0.01, 0.01 | | | |
| Constant | −0.48*** | 0.05 | −0.57, −0.39 | 1.92*** | 0.04 | 1.84, 2.00 |
| | | $R^2 = 0.49$ | | | $R^2 = 0.55$ | |
| | | $F_{(5, 3,141)} = 602.58^{***}$ | | | $F_{(6, 3,140)} = 632.36^{***}$ | |

| | | | **The conditional indirect effect of X on Y** | | |
|---|---|---|---|---|---|
| | | | ***B*** | **SE** | **95% CI** |
| | W: M − 1 SD | V: M − 1 SD | −0.22 | 0.02 | −0.25, −0.18 |
| | | V: M + 1 SD | −0.28 | 0.02 | −0.31, −0.24 |
| | W: M + 1 SD | V: M − 1 SD | −0.24 | 0.02 | −0.29, −0.20 |
| | | V: M+1SD | −0.31 | 0.03 | −0.37, −0.25 |

CI, confidence interval; TPI, teacher professional identity; POS, perceived organizational support; WE, work engagement; PR, psychological resilience; BO, burnout. $^{*}p < 0.05$; $^{***}p < 0.001$.

This study demonstrated that WE played a partial mediating role ($p < 0.001$) in the relationship between TPI and burnout, supporting H1. This result is consistent with the findings of a study conducted by Zhang et al. on health inspectors. Their research found that PI not only directly affects burnout but also reduces the likelihood of burnout through WE (31). Therefore, teachers with strong professional identities are more engaged in their work, reducing the possibility of burnout.

Furthermore, previous studies have shown that individuals with high TPI have increased positive attitudes toward and greater commitment to their profession (68). Lack of TPI leads to teachers' stress and burnout (69). The positive state of WE can be used as a protective factor to alleviate burnout (34–36). Moreover, WE could be affected by TPI among primary and secondary school teachers. Teachers with a strong sense of PI are more engaged in their work, which reduces the possibility of burnout. WE could increase the mental state of teachers' high levels of energy, thereby reducing burnout. These statements support the hypothesis that WE mediates the relationship between TPI and burnout.

## The moderating roles of POS and PR

This study found that POS plays a moderating role in the relationship between TPI and WE, supporting H2. This result is similar to that of previous findings (70). This result can be explained as follows. Previous research has shown that WE can be positively affected by PI (16). When an individual has a high degree of recognition for their work, they will put more effort into it, leading to high WE. POS is defined as whether individuals feel that the organization values their contributions, whether individuals are content with the attention they provide to the organization, and whether the school cares about the basic interests of employees (37), which might play a moderating role in the relationship between teachers' PI and WE. There is an old saying in China that a gentleman will die for his confidant. If the organization respects employees and their values and cares about their lives, employees would be doubly engaged in their work. Previous studies have proven this (46, 71). For example, the research conducted by Zacher and Winter found that perceived organizational support was beneficial to employees' WE, and POS played a moderating role in the relationship between PI and WE (46). Thus, there is evidence to support that POS played a moderating role in the relationship between TPI and WE in our study.

This study found that PR played a moderating role in the relationship between WE and burnout among primary and secondary school teachers in China, supporting H3. Compared with low PR, the influence effect of WE on burnout increased from 0.33 to 0.40 for teachers with high PR. The results of this study are consistent with those of previous studies (52, 72, 73). For example, the research conducted by Liu et al. found that teachers with high mental toughness can better adjust and overcome difficulties when facing the problem of burnout caused by the pandemic and reduce the problems caused by burnout to a certain extent (52). In teachers' daily lives, they would face many difficulties from family, students' parents, and school managers, which would aggravate the level of burnout (74). PR is an internal positive psychological resource that can help individuals successfully cope with difficulties and adapt to stress. Therefore, teachers with increased WE can reduce burnout, and teachers with good PR will suffer from less burnout.

Rather than testing the JD-R model, our research supported the JD-R model to a certain degree. First, the complete JD-R model posits that burnout was a result of an imbalance between job resources and demands. However, our research only explored the effect of job resources on reducing the level of burnout and did not explore the effect of job demands on burnout; thus, it is difficult to say that our research tested the JD-R model. We have added this to the limitations of this study and future directions. Future research could simultaneously test the effects of job demands and resources on teacher burnout. Second, the theoretical hypothesized model in our research is posited based on the JD-R model. Analysis of the data revealed that the hypothesized model was feasible, supporting the JD-R model to some degree (i.e., these variables could be regarded as job resources that affect job burnout). Based on these two reasons, we believe that we did not test the JD-R model, but support it to a certain extent through relevant data analysis.

In this study, teachers' PI, POS, and PR were all work resources that played a protective role in the occurrence of teacher burnout. Regarding the mediating role of WE, previous studies have shown that burnout is closely related to WE, and WE is positively correlated with teachers' PI. Moreover, previous research has found that burnout is negatively related to other work resources, such as self-efficacy (75), empathy (76), organizational culture (77), and emotional intelligence (78).

## Implications

From the perspective of social organization and personal psychological resources, the following suggestions are made. First, to increase perceived social support, there is a need to organize training sessions for school administrators to strengthen their understanding of online teaching principles and quality monitoring. Teachers are also encouraged to engage in online teaching. Online teaching during the pandemic is not only a disadvantage but also increases the ability of teachers to teach online. Therefore, teachers should engage in online teaching with a positive attitude. Moreover, to alleviate burnout, support from external work resources such as POS can be strengthened to ensure the normality of online teaching. In summary, schools should strive to improve the service capabilities of their teaching environment, such as ensuring that teachers reorganize teaching equipment during the teaching process and that the teaching environment is comfortable. This will result in a better teaching platform and provide necessary support tools for teaching and learning. At the same time, schools need to build a teacher professional development community to support teachers in reducing professional burnout under the conditions of long-term online teaching.

### Limitations and future directions

This study has some limitations. First, the data we collected was purely correlational, collected at a single time point, and with no experimental manipulation or random assignment, which resulted in difficulties in inferring the causal relationship. Meanwhile, one drawback of cross-sectional data that was used to test mediation effects was that it was a lack of control for prior levels of variables. Thus, the results of mediation and moderation analysis should be interpreted with caution, which refers to the causalities implicitly implied by the arrows in the mediation model and that all evidence for causation comes from either the theoretical reasoning or the existing empirical findings. Future research could adopt an experimental design or longitudinal design to test the causal relationship between these variables. Second, the large sample size of this study did not apply nationwide. The study was conducted only in Zhejiang province. Future researchers could consider other variations, such as teachers at different levels (preschool and high school teachers). Furthermore, this study can be replicated in other provinces in China. Third, our research only explored the effect of job resources on burnout, ignoring the effect of job demands on burnout, which resulted in difficulties in testing the JD-R model. Future research could simultaneously consider the influence of job demands and resources on burnout.

## Conclusion

Based on the JD-R model, this study examined several protective factors that can help reduce burnout among teachers at the organizational and individual levels. These findings suggest that WE mediates the relationship between TPI and burnout. POS moderated the relationship between TPI and WE, while PR moderated the relationship between WE and burnout. Moreover, this study provides suggestions that can help overcome the problem of burnout among primary and secondary school teachers in China during the COVID-19 pandemic. It is worth noting that, although most schools have already started online teaching, it is unclear whether online teaching will still be part of daily teaching after the pandemic. However, online teaching is an important direction for future college education reform, and this study aims to provide an organizational reference for the development of online teaching in the future.

## 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 Zhejiang Normal University. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

YL and BS: conceptualization. YL and QZ: methodology. BS and WL: validation. YL and QZ: resources. YL: writing—original draft preparation and funding acquisition. YL and MA: writing—review and editing. QZ and WL: supervision. BS: project administration. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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EDITED BY
Seung-Wan Kang,
Gachon University, South Korea

REVIEWED BY
Ahmad Adeel,
The University of Chenab, Pakistan
Fan Zhiguang,
Jilin International Studies University, China

*CORRESPONDENCE
Jeyong Jung
pancon@ulsan.ac.kr
Min-Jik Kim
mkim@koreatech.ac.kr

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# Job insecurity during the COVID-19 pandemic and counterproductive work behavior: The sequential mediation effects of job stress and organizational identification and the buffering role of corporate social responsibility

Byung-Jik Kim[1,2], Julak Lee[3], Jeyong Jung[4]* and Min-Jik Kim[5]*

[1]College of Business, University of Ulsan, Ulsan, South Korea, [2]Department Psychology, Yonsei University, Seoul, South Korea, [3]Department of Industrial Security, Chung-Ang University, Seoul, South Korea, [4]Department of Police Science, University of Ulsan, Ulsan, South Korea, [5]School of Industrial Management, Korea University of Technology and Education, Cheonan, South Korea

Swift social and economic environmental changes such as those associated with the COVID-19 pandemic have led to decreased job security. Although numerous previous studies have examined the influence of job insecurity on employee perceptions, attitudes, and behaviors, the link between job insecurity and negative behavior and its underlying or intermediating mechanisms remain underexplored. The significance of an organization's positive behaviors, which fall under the umbrella of corporate social responsibility (CSR), also deserves more attention. To address these gaps, we examined both the mediator and the moderator in the association between job insecurity and negative employee behavior by establishing a moderated sequential mediation model. We hypothesized that the levels of employee job stress and organizational identification sequentially mediate the relationship between job insecurity and counterproductive work behavior as a representative negative behavior. We also hypothesized that CSR activities play a buffering role that moderates the influence of job insecurity on job stress. We used three-wave time-lagged data collected from 348 employees in South Korean organizations to demonstrate that job stress and organizational identification sequentially mediate the relationship between job insecurity and counterproductive work behavior, and that CSR activities function as a buffering factor that decreases the influence of job insecurity on job stress. The results of this research suggest that the levels of job stress and organizational identification (as sequential mediators) as well as CSR activities (as a moderator) are underlying mechanisms in the link between job insecurity and counterproductive work behavior.

KEYWORDS

**job insecurity, counterproductive work behavior, job stress, organizational identification, CSR activities, moderated sequential mediation model**

## Introduction

Swift social and economic environmental changes brought about by events including the COVID-19 pandemic, the artificial intelligence (AI) revolution, and robot processing automation (RPA) can constitute great shocks, causing recession, and economic crisis. In order to effectively respond to such unexpected changes, organizations tend to implement massive restructuring and downsizing, causing their employees to experience high levels of job insecurity (1, 2). Job insecurity is defined as an employee's perception or belief about the uncertainty his or her employment (3). Previous studies reported that job insecurity crucially affects a variety of organizational outcomes by playing the role of a severe job stressor. For example, job insecurity has been known to substantially predict poor employee mental/physical health, perceptions, attitudes, and behaviors (e.g., job satisfaction, perceived organizational support, organizational commitment, organizational identification, organizational trust, employee engagement, creativity, and organizational citizenship behavior), and poor organizational-level outcomes (3–10). Although many studies of job insecurity have delved into the impacts of job insecurity on critical organizational outcomes, important research gaps remain (6, 9).

First, extant studies of the relationships between job insecurity and organizational outcomes are inconclusive (5, 6, 9, 11). For instance, meta-analyses showed that an unstable job substantially decreases the quality of individual-level outcomes (5). The harmful effects originate in the finding that job instability is likely to play a role-boosting factor that drastically increases employee stress and negative emotions (4, 8, 9, 11). In contrast, other studies have revealed that job instability tends to enhance the quality of employee outcomes or performance in an organization. This interesting phenomenon is based on the efforts of employees in response to job insecurity to preserve their job in the organization (10). Furthermore, research on job insecurity has shown that an unstable job is not related to employee outcomes (10, 12). These inconclusive results originate in the lack of studies on the intermediating or underlying mechanisms (i.e., mediators and moderators) of this link (9). Thus, work on the intermediating processes is critical.

Second, previous studies paid relatively less attention to employees' "negative behaviors" such as deviant or counterproductive work behavior (6, 9, 11). The extant research has mainly focused on employees' "positive" perceptions, attitudes, and behaviors such as job satisfaction, organizational commitment, organizational identification, organizational trust, voice/safety behavior, and organizational citizenship behavior (3–11). We acknowledge that positive perceptions, attitudes, and behaviors are crucial factors to determine organizational survival by significantly affecting organizational performance. However, considering that organizational life includes both positive and negative sides and that positive and negative aspects pertinent to an employee's behaviors tend to possess different psychological mechanisms, understanding the influence of job insecurity on negative behaviors is important (6, 9, 13).

Third, extant studies of job insecurity have ignored the significance of organizational positive and benevolent behaviors toward society such as corporate social responsibility (CSR) activities (6, 9, 11). Although some studies have revealed a variety of contextual variables that moderates the influences of an unstable job on organizational outcomes at the macro-economic level (e.g., labor market condition, social safety network), organizational-level (e.g., previous financial performance, productivity, and quality of organizational communication), and individual-level (e.g., employee self-efficacy, proactive coping, and job involvement), those studies did not focus on the organization's "goodness," which is one of the most essential values in human society (6, 9). Considering that kindness and goodness (e.g., benevolent activities for society) are likely to have healing effects for human beings, it is important to investigate their moderating role.

To deal with these research gaps, we investigate the mechanisms intermediating between employee job insecurity and counterproductive work behavior (CWB) as a negative behavior in an organization. CWB can be defined as intentional action by an employee that directly/indirectly harms coworkers, customers, and the organization itself (14, 15). Employee job insecurity is a critical antecedent of CWB (16, 17). An employee who feels a sense of job insecurity tends to experience serious job stress (18, 19). Such stress may motivate employees to take revenge upon the organization by engaging in CWB (15).

In specific, we suggest that employee job stress and organizational identification sequentially mediate the association between job insecurity and CWB. Moreover, corporate social responsibility (CSR) may play a buffering role in the job insecurity-job stress link by moderating this relationship.

Job insecurity would increase employee job stress. Job stress refers to negative psychological states or negative responses toward various stimuli (i.e., job stressors) such as anxiety, anger, and depression (20). Extant research demonstrated that employee job insecurity functions as one of the most serious and critical job stressors and drastically increases levels of stress at work (6, 9, 11, 18). Based on social exchange theory (21), we suggest that employee job stress is likely to decrease organizational identification (22–24). Such identification is the degree to which an employee considers himself or herself to be one with his or her organization, functioning as a "root construct" in an organization to facilitate the quality of critical organizational outcomes (23, 24).

We propose that an employee's organizational identification is negatively associated with the level of his or her CWBs. According to social identity theory (23–25), an employee with a low level of organizational identification due to high job stress is not likely to believe that the success of his or her

organization is directly related to his or her own self-concept. Thus, the employee may not facilitate behaviors to contribute to the achievement of the organization's success or to stop engaging in behaviors that detract from this goal. Eventually, he or she fails to reduce actions harmful to the organization such as CWB or even increases such negative behaviors (26–28).

We use the context–attitude–behavior perspective to integrate the relationships among job insecurity, job stress, organizational identification, and counterproductive work behavior (29) by applying it to our sequential mediation model. This perspective proposes that a variety of social and contextual factors such as rules, systems, cultures, and climates exist in an organization and plays critical roles in building employee attitudes, eventually influencing employee behaviors. Job insecurity is a crucial social context that affects employee attitudes such as job stress and organizational identification. These attitudes are likely to lead to behavior such as CWB. Relying on these arguments, in this research we propose that employee job stress and organizational identification sequentially mediate the relationship between job insecurity and CWB.

Furthermore, we suggest that CSR functions as an important moderating factor that buffers the negative influence of job insecurity on job stress. As mentioned above, our argument that employee job insecurity increases job stress may be reasonable, but the influence of job insecurity on job stress may not apply to all situations or contexts in the same way since a variety of contextual/moderating factors directly/indirectly affects the job insecurity-job stress link in real organizations. Among many potential moderators, we propose that CSR, an organizational-level benevolent activity, plays a critical moderating role by buffering the negative impact of job insecurity on job stress. CSR describes an organization's moral efforts to facilitate the welfare of many stakeholders, including shareholders, employees, customers, suppliers, the government, and the environment itself (13, 30–33).

For example, when a firm proactively implements CSR, even if an employee of the firm feels a sense of job insecurity, the negative influence of the unstable job is likely to be decreased because the employee is more likely to perceive that his or her organization is respectable or reputable. Then, the employee may feel a sense of escalated social self (23–25), eventually enhancing their pride, identification, and commitment toward his or her organization (13, 30). These positive psychological states may function as a buffering factor by reducing the negative impacts of job insecurity. In other words, the positive psychological states that originate in CSR are likely to offset the negative influence of an unstable job. In contrast, when a firm passively or rarely implements CSR, an employee who is suffering from negative feelings such as anxiety, fear, or stress from job insecurity may not have an opportunity to enhance his or her social self, pride, and positive perceptions toward his or her organization. As a result, the negative influence of job insecurity may not be resolved and could even be amplified (13, 26, 30, 33)].

Based on those findings, we attempt to analyze the influence of job insecurity on CWB through the sequential mediating effects of job stress and organizational identification. Moreover, we also propose that CSR practices play a contingent role that moderates the association between job insecurity and job stress (please see Figure 1). To empirically test our hypotheses, we built a moderated sequential mediation model with structural equation modeling (SEM) using three wave time lagged data from 348 Korean workers. We expect that this research will contribute to the literature on job insecurity and CWB as follows. First, we elucidated the inconclusive relationship between job insecurity and organizational outcomes by investigating intermediating mechanisms (i.e., mediators and moderators). Second, we found that CSR activities, as organizational-level positive and benevolent actions, play a contextual role that moderates the job insecurity-job stress link. Third, we delved into the influence of job insecurity on negative employee behaviors such as counterproductive work behavior, rather than positive perceptions or attitudes. Last, from a methodological perspective, we tried to complement the limitations of cross-sectional data by applying a longitudinal approach (i.e., 3-wave time-lagged research design).

***Hypothesis 1:*** An employee's job insecurity may increase his or her CWB.

***Hypothesis 2:*** An employee's job insecurity may increase his or her job stress.

***Hypothesis 3:*** An employee's job stress may decrease his or her organizational identification.

***Hypothesis 4:*** An employee's organizational identification may decrease his or her CWB.

***Hypothesis 5:*** Employee's job stress and organizational identification sequentially mediate the relationship between job insecurity and CWB.

***Hypothesis 6:*** CSR moderates the relationship between job insecurity and job stress.

# Methods

## Participants and procedures

We surveyed current employees of organizations in South Korea over 19 years of age across three time points. They were recruited through an online survey company offering the largest population of research panelists in Korea, ∼3,460,000 potential respondents. The participants reported their occupation status when they registered for online membership *via* a user authentication system (e.g., cellular phone number or email address). Such online survey systems have been shown to be reliable (34).

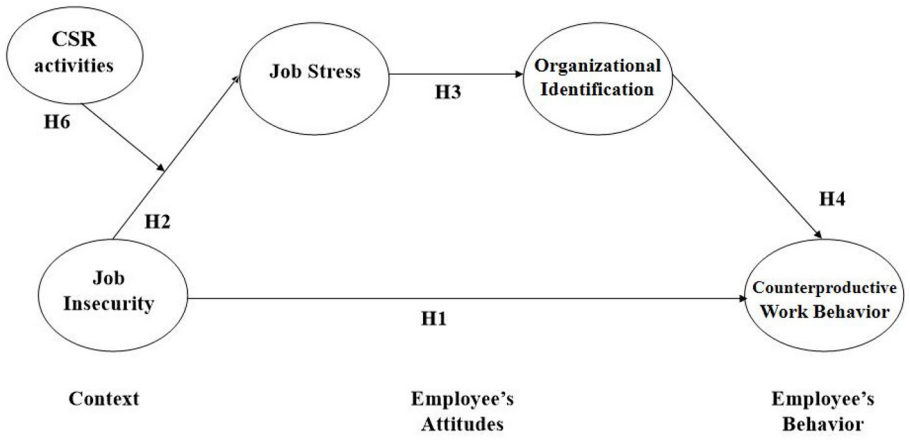


FIGURE 1
Theoretical model.

By collecting data for three time periods, we address the fundamental issue embedded in cross-sectional research design. The online system allowed us to track who responded to our survey, confirming lack of difference in participants from time point 1 to time point 3. The interval between surveys was 4 or 5 weeks. Our survey system was open for 2 or 3 days each at each time point to provide enough time for participants to respond. When the system was open, participants could access it at any time. The company monitored the integrity of data using traps for geo-IP violators and timestamps to flag efficient response. These safeguards restricted participants from logging into the survey site and filling out multiple surveys.

Experts in the research firm directly contacted participants to ask for permission to include them in our survey, assuring them that their participation was voluntary and their responses would remain confidential and only be used for research purposes. The company obtained both informed consent and agreement for compliance with ethical requirements from participants. The company provided the participants with rewards for their participation in the form of cash (US $8). This research was approved by the institutional review board (IRB) of one of the participating universities in South Korea.

The research company randomly chose participants through stratified sampling to decrease the possibility of sampling bias. Stratified random sampling reduces bias due to employee characteristics that may influence the results of research (e.g., gender, age, position, education, and industry type). Using online survey tools, we were able to verify the lack of difference in respondents from time point one to time point three.

At time point 1, 512 employees participated in our survey; at time point 2, 421 workers participated in the second survey; and at time point 3, 357 employees responded to the third survey. To determine the sample size, we consulted previous research. First, we calculated the minimum sample size using G*Power version 3.1.9.7. A power analysis using this program demonstrated that a sample size of 348 provided sufficient power ($\geq$0.80) to detect a medium effect with an alpha level of $p = 0.05$ (35). In addition, Barclay et al. (36) suggested that one observable variable must be analyzed in at least 10 cases (i.e., the rule of 10) with SEM. Because this study includes 22 observable variables, our 348 cases (response rate: 67.97%) comprise an adequate sample. The time intervals among the time points were ~5 or 6 weeks. We deleted missing data from the raw material after 6 weeks. The characteristics of the sample are described in Table 1.

## Measures

The survey measured distinct variables in our research model at each time point. At time point 1, the respondents were asked about job insecurity and CSR activities. At time point 2, we measured degrees of job stress and organizational identification. At time point 3, we collected data about participants' CWB. These variables were assessed through multi-item scales on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). We computed the internal consistency of each variable using Cronbach's alpha.

## Job insecurity (time point 1, collected from employees)

We used four items for the job insecurity scale (37). Sample items were "If my current organization were facing economic problems, my job would be the first to go," "I will not be able

TABLE 1 Descriptive characteristics of the study sample.

| Characteristic | Percent |
|---|---|
| **Gender** | |
| Male | 50.0% |
| Female | 50.0% |
| **Age (years)** | |
| 20–29 | 14.7% |
| 30–39 | 35.3% |
| 40–49 | 33.9% |
| 50–59 | 16.1% |
| **Education** | |
| Less than high school | 8.6% |
| Community college | 19.3% |
| Bachelor's degree | 59.8% |
| Master's degree or higher | 12.4% |
| **Occupation** | |
| Office worker | 71.3% |
| Professional (Practitioner) | 7.2% |
| Public official | 6.0% |
| Manufacturing | 5.7% |
| Sales and marketing | 4.3% |
| Administrative | 4.0% |
| Education | 0.3% |
| Others | 1.2% |
| **Position** | |
| Staff | 25.0% |
| Assistant manager | 21.6% |
| Manager or deputy general manager | 31.9% |
| Department/general manager or director and above | 21.5% |
| **Tenure (years)** | |
| <5 | 46.8% |
| 5–10 | 27.1% |
| 11–15 | 12.9% |
| 16–20 | 7.5% |
| 21–25 | 2.3% |
| More than 26 | 2.9% |
| **Industry type** | |
| Manufacturing | 24.4% |
| Services | 18.6% |
| Construction | 11.9% |
| Health and welfare | 10.2% |
| Information services and telecommunications | 8.7% |
| Education | 8.4% |
| Financial/insurance | 4.1% |
| Consulting and advertising | 1.2% |
| Others | 12.5% |

to keep my present job as long as I wish," and "My job is not a secure one." The Cronbach's alpha value was 0.90.

## CSR (time point 1, collected from employees)

The CSR was measured using 12 items from the CSR scale suggested by Farooq et al. (38), which originated in Turker's CSR measure (39). The scale we utilized in this study consists of four dimensions for measuring CSR activities: (1) environment, (2) community, (3) employee, and (4) customer. Each of the four domains includes three items and indicates the corresponding stakeholders in the organization's social responsibility. For the environment domain, a sample item is "our organization participates in activities that aim to protect and improve the quality of the natural environment." For the community domain, a sample item is "our organization contributes to campaigns and projects that promote the wellbeing of society." For the employee domain, a sample item is "our organization supports employee growth and development." For the customer domain, a sample item is "our organization respects consumer rights beyond legal requirements." All items were previously used in empirical studies conducted in South Korean contexts [e.g., (7, 40)]. The Cronbach's alpha value was 0.91.

## Job stress (time point 2, collected from employees)

To measure levels of employee job stress, we used four items of a job stress scale adapted from previous work (7, 41). Sample items were "At work, I felt stressed during the last 30 days," "At work, I felt anxious during the last 30 days," and "At work, I felt frustrated during the last 30 days." The Cronbach's alpha value was 0.89.

## Organizational identification (time point 2, collected from employees)

To measure the degree of employee organizational identification, we utilized five items from Mael and Ashforth (42). Some sample items are "When someone criticizes my organization, it feels like a personal insult" and "My organization's successes are my successes." The Cronbach's alpha value was 0.84.

## Counterproductive work behavior (time point 3, collected from employee supervisors)

The degree of CWB was measured through five items of the CWB scale by Fox et al. (14). The employees' immediate supervisor evaluated the level of employee CWB. A sample is

"This employee purposely worked slowly when things needed to get done." The Cronbach's alpha value was 0.91.

## Control variables

Based on previous research (43), the dependent variable, CWB, was impacted by factors such as tenure, gender, position, and education of an employee. The control variables were collected at time point 2.

## Statistical analysis

First, frequency analysis was performed to assess the participants' demographic features. We conducted Pearson correlation analysis in SPSS 26 to compute the relationships among our research variables. Then, following Anderson and Gerbing (44), we used a two-step approach that consists of (1) measurement and (2) application of the structural model. To test the validity of the measurement model, we performed confirmatory factor analysis (CFA). Next, based on SEM, a moderated mediation model with the maximum likelihood (ML) estimator was used with the AMOS 23 program to test the structural model.

To test whether various model fit indexes were acceptable, we utilized a variety of goodness-of-fit indices including the comparative fit index (CFI), the Tucker–Lewis index (TLI), and the root mean square error of approximation (RMSEA). Previous research reported that CFI and TLI values >0.90 and RMSEA values <0.06 are appropriate (45). A bootstrapping analysis was implemented to test whether the indirect effect was significant (46) and whether our mediation hypothesis was supported with a 95% bias-corrected confidence interval (CI). If the CI does not include zero (0), this indicates that the indirect effect is statistically significant at the 0.05 level (46).

# Results

## Descriptive statistics

Our research variables, including job insecurity, CSR, job stress organizational identification, and CWB, were significantly related. The correlation analysis results are shown in Table 2.

## Measurement model

To test the discriminant validity of the main research variables (job insecurity, CSR, job stress, organizational identification, and CWB), we performed a CFA for all items by assessing the measurement model's goodness-of-fit. To be specific, we compared our hypothesized model, a 5-factor model (job insecurity, CSR, job stress, organizational identification, and CWB), to other alternative models with fewer factors using a series of chi-square difference tests.

First, the hypothesized 5-factor model had a good and acceptable fit [$\chi^2$ (df = 94) = 186.013; CFI = 0.970; TLI = 0.962; RMSEA = 0.053]. Then, we conducted a series of chi-square difference tests by comparing the 5-factor model to a 4-factor model [$\chi^2$ (df = 98) = 732.341; CFI = 0.795; TLI = 0.749; RMSEA = 0.137], a 3-factor model [$\chi^2$ (df = 101) = 1,326.855; CFI = 0.604; TLI = 0.529; RMSEA = 0.187], a 2-factor model [$\chi^2$ (df = 103) = 1,811.057; CFI = 0.448; TLI = 0.356; RMSEA = 0.219], and a 1-factor model [$\chi^2$ (df = 104) = 2,372.264; CFI = 0.266; TLI = 0.154; RMSEA = 0.251]. The 5-factor model was better than all others, indicating that the five variables have an appropriate degree of discriminant validity.

TABLE 2 Correlations among research variables.

| | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gender_T2 | 1.50 | 0.50 | – | | | | | | | |
| 2. Education_T2 | 2.76 | 0.78 | −0.14** | – | | | | | | |
| 3. Tenure_T2 | 7.42 | 7.18 | −0.25** | 0.02 | – | | | | | |
| 4. Position_T2 | 2.90 | 1.61 | −0.43** | 0.21** | 0.28** | – | | | | |
| 5. Job insecurity_T1 | 2.78 | 0.82 | −0.11** | −0.06 | −0.003 | 0.11* | – | | | |
| 6. CSR_T1 | 3.19 | 0.68 | −0.17** | 0.13* | 0.18** | 0.16** | −0.13* | – | | |
| 7. Job Stress_T2 | 2.93 | 0.76 | −0.001 | −0.09 | 0.22 | −0.06 | 0.25** | −0.11* | – | |
| 8. OI_T2 | 3.42 | 0.71 | −0.17** | 0.92 | 0.14* | 0.20** | −0.08 | 0.41** | −0.18** | – |
| 9. CWB_T3 | 2.31 | 0.77 | −0.10 | −0.93 | 0.70 | −0.07 | 0.18** | −0.08 | 0.26** | −0.19** |

*p < 0.05. **p < 0.01. S.D, deviation; CSR, corporate social responsibility; OI, organizational identification; CWB, counterproductive work behavior.

TABLE 3 Results of the structural model.

| Hypothesis | Path (Relationship) | Estimate | S.E. | Standardized estimate | Supported |
|---|---|---|---|---|---|
| 1 | Job insecurity → CWB | 0.142 | 0.049 | 0.167** | Yes |
| 2 | Job insecurity → Job stress | 0.208 | 0.049 | 0.241*** | Yes |
| 3 | Job stress → OI | −0.154 | 0.052 | −0.178** | Yes |
| 4 | OI → CWB | −0.251 | 0.067 | −0.220*** | Yes |
| 6 | Job insecurity × CSR | −0.209 | 0.063 | −0.181*** | Yes |

**p < 0.01. ***p < 0.05. Estimate indicates standardized coefficients. SE, standard error.

## Structural model

The current study includes a moderated sequential mediation model of the job insecurity-CWB link. In the sequential mediation structure, the job insecurity-CWB link is sequentially mediated by degree of employee job stress and organizational identification. In the moderation structure, CSR activities function as a buffering factor that moderates the impact of job insecurity on job stress.

Next, in the moderation structure, we multiplied the two variables (i.e., job insecurity and CSR) to form an interaction term. Before multiplication, the two variables were centered on their respective means to increase the validity of the moderation analysis by diminishing the degree of multi-collinearity between variables and minimizing the loss of correlations (47).

To test the impact of multicollinearity bias, we measured the values of variance inflation factors (VIF) and tolerances (47). The VIF values for job insecurity and CSR were 1.02 and 1.02, respectively. The values of tolerance were 0.98 and 0.98, respectively. The finding of VIF values smaller than 10 with tolerance values above 0.2 indicates that job insecurity and CSR are relatively free from the multi-collinearity issue.

## Results of mediation analysis

To determine the best mediation model, we compared a full mediation model to a partial mediation model using a chi-square difference test. The full mediation model is identical to the partial mediation model except that it includes a direct path from job insecurity to counterproductive work behavior. The fit indices of both the full mediation model [$\chi^2 = 259.476$ (df = 118), CFI = 0.949, TLI = 0.933, and RMSEA = 0.059] and the partial mediation model [$\chi^2 = 251.185$ (df = 117), CFI = 0.951, TLI = 0.936, and RMSEA = 0.057] were acceptable. However, the chi-square difference test between the models [$\Delta\chi^2_{(1)} = 8.291$, $p < 0.01$] demonstrated that the partial mediation model was superior and indicates that job insecurity influences CWB indirectly rather than directly.

Control variables, such as tenure, education, and position, were included in the research model of the dependent variable, CWB. Only position ($\beta = -0.12$, $p < 0.05$) and gender ($\beta = -0.12$, $p < 0.05$) were statistically significant. By including the control variables, our research model showed that job insecurity is significantly and positively associated with CWB ($\beta = 0.17$, $p < 0.01$), supporting Hypothesis 1; that job insecurity is significantly and positively associated with job stress ($\beta = 0.24$, $p < 0.001$), supporting Hypothesis 2; that job stress is significantly and negatively associated with organizational identification ($\beta = -0.18$, $p < 0.01$), supporting Hypothesis 3; and that organizational identification is significantly and negatively related to CWB ($\beta = -0.22$, $p < 0.001$), supporting Hypothesis 4 (Table 3, Figure 2).

## Bootstrapping

To test the sequential mediation effects of job stress and organizational identification in the job insecurity-CWB link (Hypothesis 4), we conducted a bootstrapping analysis with a sample of 10,000 (46). The indirect mediation effect would be significant at a 5% level if the 95% bias-corrected confidence interval (CI) for the effect of mean indirect mediation excludes 0 (46).

The bias-corrected CI for the mean indirect effect did not include 0 [95% CI = (0.002, 0.025)]. This means that that the indirect sequential mediation effects of job stress and organizational identification were statistically significant, supporting Hypothesis 5. The direct, indirect, and total effects of the paths from job insecurity to CWB are shown in Table 4.

## Moderation analysis

We tested the moderation effect of CSR activities on the relationship between job insecurity and job stress through a mean-centering process using an interaction term. The coefficient of the interaction term ($\beta = -0.18$, $p < 0.001$) was statistically significant. This means that CSR activities moderate the relationship between job insecurity and job stress by playing a buffering role. When the level of CSR is high, the impact of

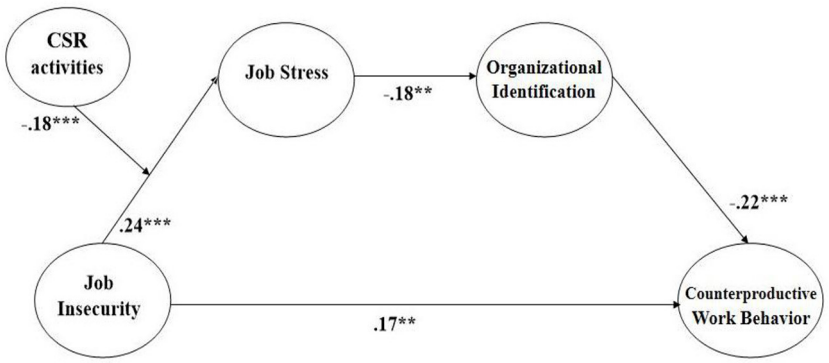


FIGURE 2
Coefficient values of our research model (**$p < 0.01$, ***$p < 0.001$. All values are standardized).

TABLE 4 Direct, indirect, and total effects of the final research model.

| Model (Hypothesis 5) | Direct effect | Indirect effect | Total effect |
|---|---|---|---|
| Job insecurity → Job stress → OI → CWB | 0.166 | 0.100 | 0.176 |

All values are standardized.

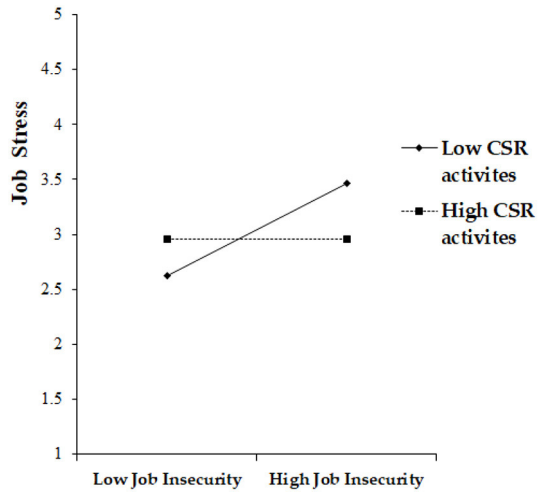


FIGURE 3
Moderating effect of CSR in the job insecurity–Job stress link.

job insecurity on job stress is decreased, supporting Hypothesis 6 (please see Figure 3).

## Discussion

Using 3-wave time-lagged data obtained for 348 employees in South Korea, we demonstrated that employee job stress and organizational identification function as sequential mediators in the job insecurity-CWB link. Moreover, we determined that CSR plays a buffering role that reduces the negative impact of job insecurity on job stress. In the following sections, we describe the theoretical/practical implications and limitations of this paper and suggest ideas for future research.

## Theoretical implications

We expect that the current research can contribute to the job insecurity literature from the theoretical point of view. First, to address the issue of inclusive results between job insecurity and organizational outcomes, we investigated the intermediating processes (i.e., mediators and moderators) (9). To be specific, based on the context–attitude–behavior perspective (29), we delved into the sequential mediating effect of employee job stress and organizational identification in the job insecurity-CWB link. Furthermore, we examined whether CSR activity functions as a buffering factor in the association between job insecurity and job stress.

In line with previous hypotheses and empirical studies, our results showed that employee job insecurity plays a role as a job stressor that substantially increases job stress (18). We found that employee job insecurity negatively influences work behavior. The degree of employee organizational identification is negatively related to his or her CWB (23–25). The overall mediating structure in the link was statistically validated. In addition, we identified CSR activities as a buffering factor explaining the job insecurity-job stress link. In summary,

we believe that this research can contribute to the job insecurity literature by bolstering existing studies that showed the detrimental impacts of job insecurity.

Second, we demonstrated that an organization's good and benevolent behavior to benefit society (i.e., CSR activity) functions as a critical contingent variable that moderates the job insecurity-job stress link. From the perspective of an employee, when the organization to which he or she belongs is perceived as reputable and respectable by proactively fulfilling responsibilities for its society, the employee is likely to feel a sense of escalated social self, enhanced pride, and positive perceptions toward the organization. These positive psychological states then directly/indirectly reduce the negative influences of job insecurity. In other words, the positive perceptions or emotions that originate in CSR offset the negative impacts of an unstable job. These results show the importance of organizational-level benevolent activities, which can be measured as level of CSR activities, as well as the necessity of good deeds in dealing with the negative impacts of job insecurity in an organization.

Third, we investigated the influence of job insecurity on employee CWB, as one of the critical 'negative behaviors' in an organization. Although many scholars have described the impact of job insecurity in organizations, previous studies have tended to focus on employees' positive perceptions, attitudes, and behaviors (e.g., organizational identification, employee engagement, job satisfaction, voice/safety behavior, organizational citizenship behavior, and innovative behavior), paying relatively less attention to negative behavior, such as CWB. Given that organizational life includes both positive and negative perspectives, but also that employees' positive and negative behaviors originate in different psychological mechanisms, our attempt to examine the impact of job insecurity on CWB contributes to the job insecurity literature (9, 13).

## Practical implications

This research may provide some practical contributions for top management teams who want not only to understand the impacts of job insecurity on employee behaviors, but also to decrease the negative impacts. First, based on the empirical results of our research, we expect that top management teams could better understand the seriously harmful effects of job insecurity on employee behaviors. We empirically showed that job insecurity substantially increases negative behavior (i.e., CWB), which is closely related to organizational outcomes. Considering that an employee's behaviors tend to be directly associated with organizational performance, the degree of employee job insecurity could critically deteriorate an organization's competitive advantage and sustainability. The current study suggests that top management teams should understand and carefully resolve these important issues based on a variety of rules, incentives, practices, and systems.

Second, the current study also provides direction for top management teams to diminish the negative influence of job insecurity in an organization. We suggest that leaders understand and adequately use the buffering effect of CSR to decrease the harmful results of job insecurity. Top management teams should not only actively implement CSR activities, but also effectively inform the employees of the organization's benevolent actions to aid society. Top management teams should consider the CSR activities as an effective investment instead of a reluctant moral duty. The good and benevolent behaviors of an organization (i.e., CSR) may significantly reduce the negative impacts of job insecurity.

Third, we provide useful indicators or criteria for top management teams who want to monitor and assess the harmful impacts of job insecurity as well as the effectiveness of various buffering factors (e.g., a variety of human resource management systems and practices for reducing the harmful effects of job insecurity). The results of this study demonstrate that degree job stress and organizational identification function as sequential mediators in the job insecurity-counterproductive work behavior link. This means that job stress and organizational identification are important criteria to understand and evaluate how job insecurity influences negative employee behavior. In addition, as aforementioned, the buffering effects of CSR activities can be measured or estimated by assessing change in job stress and organizational identification. In other words, when job stress and organizational identification are not changed after actively implementing CSR activities, this indicates that positive impacts of CSR may not be realized. In sum, we suggest that top management teams monitor the levels of sequential mediators to assess the impacts of both job insecurity and its buffering factors in an organization.

## Limitations and suggestions for future research

Although we believe our research meaningfully contributes to the job insecurity and CWB literature, there are some limitations. First, we could not measure the degrees of job insecurity and CSR activities in an objective manner because we utilized only self-reported survey data that is likely to be subjective. Although we acknowledge that objective phenomena such as amount of CSR investment and downsizing rate are not likely to directly affect employee perceptions, attitudes, and behaviors, the objective measures are likely to be unconsciously reflected in his or her reactions. Therefore, we suggest that future research utilize both subjective and objective measures and compare the differential influences. Second, we did not

adequately consider external factors that significantly influence the degree of job insecurity. A variety of objective variables surrounds an employee's perception of his or her job insecurity including downsizing rates, quality or features of HRM systems, and characteristics of the social security system at the national level (7). Thus, we suggest that further research should control for such objective variables.

Third, although the fundamental values that CSR pursues should be universal in Western and Eastern contexts (48, 49), cultural differences are likely to exist affecting employee perceptions toward CSR activities. As South Korea has experienced rapid economic growth, there is a possibility that employees of South Korean firms may react differently to moral activities compared to employees of Western organizations (48). Therefore, the results of the current research should be carefully interpreted.

## Conclusion

Relying on a context–attitude–behavior perspective, we assessed the influence of job insecurity on CWB. Our results demonstrated that job insecurity increases employee CWB *via* the sequential mediating roles of job stress and organizational identification. CSR functions as a positive moderator in the job insecurity–job stress link. These results indicate that the degrees of employee job stress and organizational identification are intermediating processes translating job insecurity into negative behavior. Moreover, CSR activities diminish the negative impact of job insecurity in an organization. Although this research has limitations, the current study can positively contribute to the job insecurity literature.

## 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/animal participants were reviewed and approved by Macromill Embrain Group of Ethics Committee.

## Author contributions

B-JK contributed by writing the original draft of the manuscript and in the conceptualization, data collection, formal analysis, and methodology. JJ, JL, and M-JK contributed in the conceptualization, analysis, revision, and editing the manuscript. All authors have read and agreed to the published version of the manuscript.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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EDITED BY
Wulf Rössler,
Charité University Medicine Berlin, Germany

REVIEWED BY
Fan Zhiguang,
Jilin International Studies University, China
Jakariya Md.,
North South University, Bangladesh

*CORRESPONDENCE
Laura S. Rozek
✉ lr898@georgetown.edu
Jin-Ha Yoon
✉ flyinyou@yuhs.ac

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# Risk of psychological distress by decrease in economic activity, gender, and age due to COVID-19: A multinational study

Minji Kim[1], Byungyoon Yun[2], Juho Sim[3], Ara Cho[3], Juyeon Oh[3], Jooyoung Kim[4], Kowit Nambunmee[5,6], Laura S. Rozek[7]* and Jin-Ha Yoon[8]*

[1]Yonsei University College of Medicine, Seoul, Republic of Korea, [2]Department of Preventive Medicine, Yonsei University College of Medicine, Seoul, Republic of Korea, [3]Department of Public Health, Graduate School, Yonsei University, Seoul, Republic of Korea, [4]Catholic University of Korea College of Medicine, Seoul, Republic of Korea, [5]School of Health Science, Mae Fah Luang University, Chiang Rai, Thailand, [6]Urban Safety Innovation Research Group (USIR), Mae Fah Luang University, Chiang Rai, Thailand, [7]Georgetown Lombardi Comprehensive Cancer Center, Georgetown University, Washington, DC, United States, [8]The Institute for Occupational Health, Yonsei University College of Medicine, Seoul, Republic of Korea

**Introduction:** Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2-virus. COVID-19 has officially been declared as the latest in the list of pandemics by WHO at the start of 2020. This study investigates the associations among decrease in economic activity, gender, age, and psychological distress during the COVID-19 pandemic considering the economic status and education level of countries using multinational surveys.

**Methods:** Online self-report questionnaires were administered in 15 countries which were spontaneously participate to 14,243 respondents in August 2020. Prevalence of decrease in economic activity and psychological distress was stratified by age, gender, education level, and Human Development Index (HDI). With 7,090 of female (49.8%), mean age 40.67, 5,734 (12.75%) lost their job and 5,734 (40.26%) suffered from psychological distress.

**Results:** Associations among psychological distress and economic status, age, and gender was assessed using multivariate logistic regression, adjusted for country and education as random effects of the mixed model. We then measured the associations between HDI and age using multivariate logistic regression. Women had a higher prevalence of psychological distress than men with 1.067 Odds ratio, and younger age was significantly associated with decrease in economic activity for 0.998 for age increasing. Moreover, countries with lower HDI showed a higher prevalence of decrease in economic activity, especially at lower education levels.

**Discussion:** Psychological distress due to COVID-19 revealed a significant association with decrease in economic activity, women, and younger age. While the proportion of decrease in economic activity population was different for each country, the degree of association of the individual factors was the same. Our findings are relevant, as women in high HDI countries and low education level in lower HDI countries are considered vulnerable. Policies and guidelines for both financial aid and psychological intervention are recommended.

KEYWORDS

**COVID-19, job loss and unemployment, psychological distress, multinational survey, human development index**

# 1. Introduction

Zoonotic diseases are increasing at an alarming rate in nowadays. These various issues from such disease are newly emerging, and there are new diseases that are re-emerging (1). Especially COVID-19, which has officially been declared as the latest in the list of pandemics by WHO at the start of 2020, has caused over 6.80 million deaths as of January 2023 (2–4). While the first wave of COVID-19 made a huge impact, various variants have since changed the face. In particular, the Omicron version has been the only one in circulation for quite some time, and subvariants mutations have also been emerged (5). There are recent researches that SARS-COV-2 genetic markers in wastewater is useful to identify high-prevalence location of COVID-19 infection, which might reduce the burden of the public health system during COVID-19 pandemics (6, 7).

The COVID-19 also affects psychological distress in several ways, including fear and uncertainty, social isolation, financial stress, health anxiety, and trauma. Based on Cognitive Appraisal Theory, the pandemic has been a major stressor for many people and individuals' cognitive appraisals of the situation can play a significant role in determining their emotional and behavioral responses (8). For example, individuals who view the pandemic as a threat to their health or economic status may experience greater levels of anxiety or fear. Moreover, biopsychosocial model suggest that the pandemic has had a wide range of impacts on individuals' physical health, psychological well-being, and social interactions (9). For example, individuals who experience physical symptoms of COVID may also experience anxiety or depression, and social distancing measures may limit social support and exacerbate feelings of isolation.

Psychological distress refers to increased depressive symptom of anxiety symptom during pandemic. Psychological distress symptoms, of all levels, are associated with an elevated risk of all-cause and cardiovascular-specific mortality (10). Also, some research shows psychological distress is associated with suicide mortality. Moreover, such psychological distress cause significant economic burden (11, 12). Especially this study focused on the part of pandemic which has had a significant impact on the global economy, and cause numerous job loss or financial hardship.

To prevent the worldwide spread of COVID-19, social distancing policies were chosen as non-pharmaceutical interventions (13). Recession due to COVID-19 consequently led to diminishing employment status in various industries such as service and manufacturing sectors; the leisure and hospitality industries have been impacted the hardest (14). Specifically, the instability of the global economy caused a massive loss of employment, which reached an estimated 20 million jobs by April 6, 2020, far more than jobs lost during the entire Great Recession (15). Considering that economic activity is an important factor to maintain quality of life and job loss is one of the most crucial issues in the occupational health area (16, 17), early retirement and phobia due to the pandemic can aggravate the mental health of workers (18).

Financial stress can contribute to anxiety and depression. Furthermore, these people may become more susceptible to mental health impairments, including suicidality (16, 18). Moreover, individuals who are facing unemployment go through significant stress not only with job loss but also during the job search (18). This study draws attention to the psychological trauma that can result from decrease in economic activity and job search, and motivates psychologists to consider issues of work-life spillover in the aftermath of the pandemic.

Importantly, the impact of a recession does not affect all individuals and all countries equally (19). Gender, age, employment, income, education level, and social relationships are individual factors that have a bearing on resilience (19). Socio-economic factors can also influence these effects. Analysis of the policies implemented in some countries during economic crises reveals a link between these policies and their impact on the mental health of the population (20, 21). In this respect, vulnerable groups—people with higher risk of psychological distress—would be at higher risk. There has been vast research on mental health regarding hospital care workers during COVID-19 (22). However, the current literature has not identified individuals based on socio-economic factors, who are vulnerable to the pandemic across all occupations. Therefore, clearer results are needed to discern who needs social support.

Furthermore, research has only focused on some countries and has not covered worldwide issues, especially since COVID-19 did not continue to pose as serious a threat in several countries (23–26). During the Great Recession, Americans were more adversely affected than Europeans by the country's lack of robust safety net programs, which mitigated the psychological impact of decrease in economic activity (27). Hence, more comprehensive analysis using various demographic and social factors with worldwide surveys is needed. This research was conducted to highlight demographic and social factors of a specific population group at high risk of psychological distress due to COVID-19. Herein, we aim to examine the hypothesis that decrease in economic activity due to COVID-19 is significantly associated with psychological distress, using obtained data from 15 countries in three regions, including Asia (China, Hong Kong-China, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Taiwan, Thailand, Vietnam); Europe (Poland, Germany, Sweden, Turkey, Ukraine); and America (Canada, United States). We hope that our comprehensive analysis elucidates vulnerable populations and helps establish guidelines to address mental concerns in the aftermath of COVID-19.

# 2. Methods

## 2.1. Data set and participants

Online self-report questionnaires were administered in the 15 countries mentioned above. Most countries conducted survey using online survey website from the United States, except that Korea use their own survey website. The informed consent was obtained from each participant before the survey starts. The participants were selected by age-sex stratified random sampling with the goal of 1,000 people in each country. For an accurate survey on employment status, subjects aged above 20 and under 65 years old of working age were selected (Supplementary Figure S1). The exclusion criteria were as follows: participants who did not answer job loss or employment status questionnaires; participants who did not answer questions about psychological distress of depressive symptom or anxiety symptom; and participants who were missing their responses about each category including "sex," "employment status," "depressive symptom," "anxiety symptom" of the questionnaires.

The study protocol was in accordance with the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the

Institutional Review Board of Severance Hospital (IRB: Y-2020-0088). All participants provided informed consent before completing questionnaires.

## 2.2. Definition and evaluation of data

### 2.2.1. Psychological distress

The primary outcome variable of the study was psychological distress due to the COVID-19 pandemic. The participants were asked to indicate the extent to which they had feelings of depressive symptom and anxiety symptom, respectively. The question was: "How much have you been feeling the following emotions (depressed, anxious) during the pandemic, relative to how much you experienced them before the pandemic?" The responses were "less," "same," and "more."

### 2.2.2. Decrease in economic activity due to COVID-19

The "Decrease in economic activity due to COVID-19" group was defined based on one of the following criteria: (1) who responded "Reduced income" or "Loss of job" to the following question "Have you experienced any difficulties during the COVID-19 crisis?"; (2) those who lost a job or hours of work because their employer shut down or downsized due to COVID-19; and (3) who responded "Lost a job or hours because my employer shut down/downsized due to COVID-19" or "Left a job because I did not think it safe to work during the COVID-19 crisis." to the following question "Which statement best describes your current employment status?"

### 2.2.3. Education level

The participants were asked to indicate their highest level of education as follows: "Less than high school," "High school," "Some college or post-secondary education," "4-year college graduate," "Graduate or Professional training beyond college," "Doctoral degree (PhD)." We recategorized the education level into 4 groups by combining the first and last two groups into one group. Consequently, the education level was classified into four categories: "High school or less," "College," "University," and "Graduate or more."

## 2.3. Statistical analysis

The differences in baseline characteristics stratified by gender were examined using chi-squared and t-tests for categorical and continuous variables. Prevalence of decrease in economic activity due to the COVID-19 pandemic was calculated according to country, gender, age, and education. Odds ratio (OR) with 95% confidence intervals (CIs) of psychological distress and decrease in economic activity due to COVID-19 pandemic was calculated using multiple logistic regression analysis. Several covariates such as country, gender, age, and education level were included in the multivariate logistic regression models. To find associating factors, we used a mixed model to regard age, gender, economic status as fixed effects, and country and education as random effects. A $p$ value less than 0.05 was considered as statistically significant. All statistical analyses were performed using R version 4.0.2 (The R Foundation for Statistical Computing, Vienna, Austria).

# 3. Results

From a total of 16,942 participants, 2,298 either under 20 or over 65 years of age and 401 with missing values were excluded. Ultimately, 14,243 (men = 7,153 or 50.2%; women = 7,090 or 49.8%) were enrolled in this study. Mean (standard deviation) age of the entire sample was 40.67 (12.23) years old. Among all participants, 3,098 (12.75%) lost their job and 5,734 (40.26%) suffered from psychological distress. Regarding education level, 6,182 (40.40%) of the participants were university graduates, followed by 3,254 (33.85%) with a graduate degree or higher. Of the remaining participants, 2,787 (19.57%) completed high school or less, and 2,020 (14.18%) had completed college education. Detailed information about each country's baseline characteristics is summarized in Supplementary Table S1.

The proportions of decrease in economic activity and psychological distress due to COVID-19 stratified by gender in 15 countries are summarized in Figure 1. The average decrease in economic activity proportion of all countries was 21.75% (20.58% for women and 22.91% for their men counterparts). The top three countries with the highest unemployment rates due to COVID-19 were the Philippines (41.94%), Thailand (36.68%), and Vietnam (32.74%). Hong Kong was the country with the biggest difference in unemployment rates, which was higher for women than men ($p = 0.033$). Meanwhile in Indonesia ($p = 0.014$) and Malaysia ($p = 0.032$), men had higher unemployment rates than women.

However, women experienced more depressive symptom and anxiety symptom due to COVID-19 compared to men in all countries examined. The average prevalence of psychological distress in all countries was 59.74% (63.17% for women and 56.34% for men). The four countries which showed the largest difference in psychological distress by gender were South Korea (16.88%, < 0.001), Germany (15.42%, < 0.001), Poland (14.31%, < 0.001), and Hong Kong (13.21%, 0.003).

Figure 2 illustrates the proportions of decrease in economic activity and psychological distress due to COVID-19 by country and age. In most countries, decrease in economic activity has been more frequent among younger demographic groups. It was especially prominent in Canada, Sweden, Thailand, and Ukraine. Singapore is one of the only countries that seemed to have higher decrease in economic activities for older people.

Moreover, young participants tend to feel more psychological distress due to COVID-19 compared to older ones, although this was not as prominent as decrease in economic activity. This was especially noticeable in Sweden, the Philippines, and China. However, Singapore and Vietnam showed the opposite result, while South Korea had a high rate of depressive symptom and anxiety symptom regardless of age.

Decrease in economic activity was more common among adults with lower education levels and those without a university degree compared to those who graduated university or held a higher degree (Figure 3). This tendency stands out in the Philippines, Thailand, Vietnam, and Turkey. We hypothesized that people with lower education level would feel more depressive symptom and anxiety symptom. However, the results indicated otherwise—countries such as China, Malaysia, and the United States, which have a lower correlation between education and decrease in economic activity, also showed higher psychological distress with higher education level. Psychological distress rate in the USA with education level of high

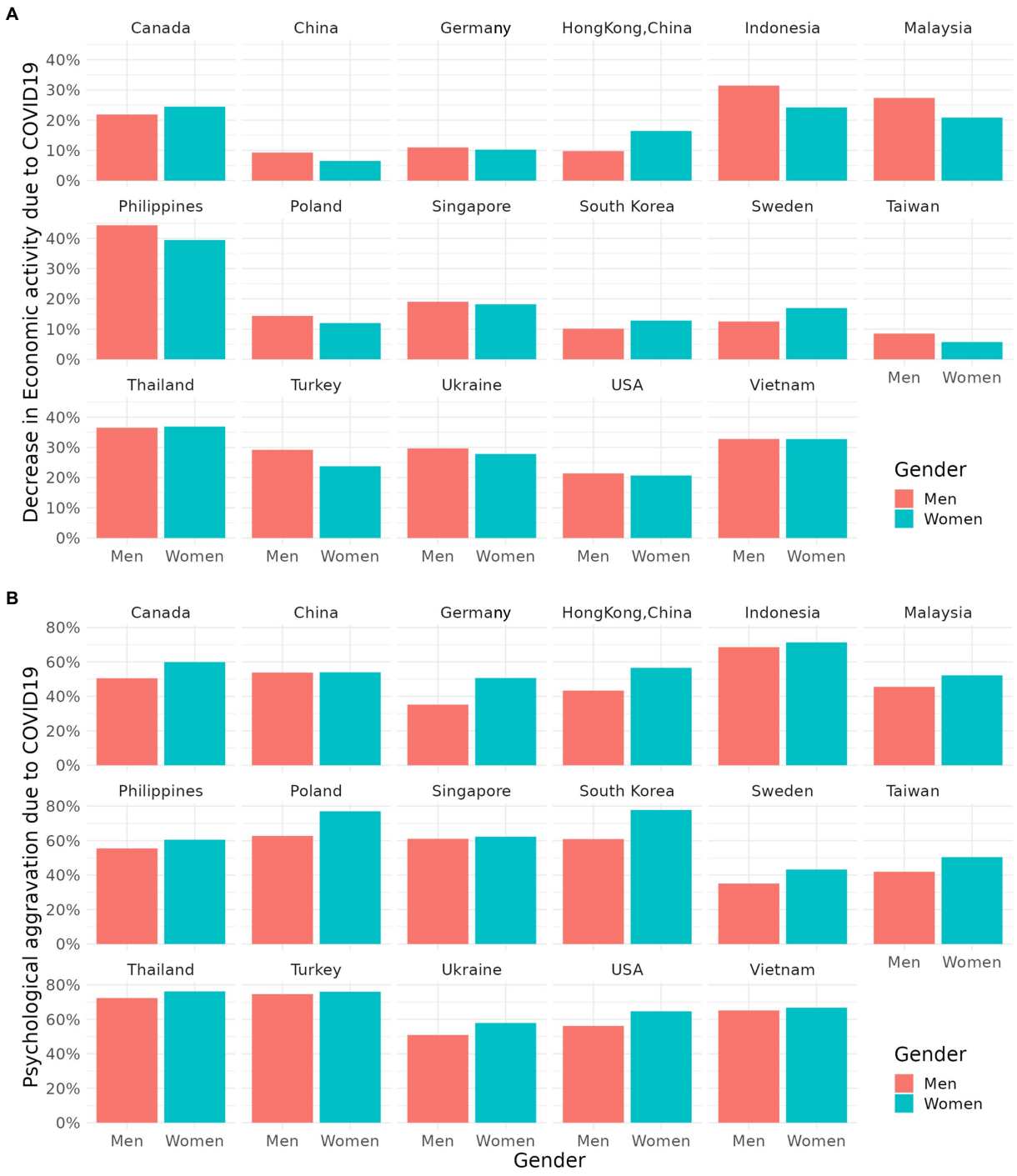


FIGURE 1
**(A,B)** Proportion of Job loss and psychological distress due to COVID-19 stratified by gender.

school or less, college, university, and graduate or more was 51.33, 6.053, 61.63, and 56.7%, respectively.

Figure 4 illustrates the prevalence of decrease in economic activity due to COVID-19 versus the Human Development Index (HDI) of each country stratified by gender. The HDI used in this study is from the 2020 UN Human Development Report, which is a statistical index composed of life expectancy, education, and *per capita* income indicators (28). HDI and proportion of decrease in economic activity due to COVID-19 were negatively associated both for men and women. Countries with lower HDI indexes indicated higher decrease in economic activity due to the COVID-19 pandemic. Moreover, for women, decrease in economic activity was lower in countries with higher HDI.

Finally, Figure 5 shows analyzation of various variables such as HDI, education level, age, psychological distress, decrease in economic activity, by each sex strata. Age, HDI, decrease in economic activity presented stronger linear correlation among each other, with prominent extent of association in men.

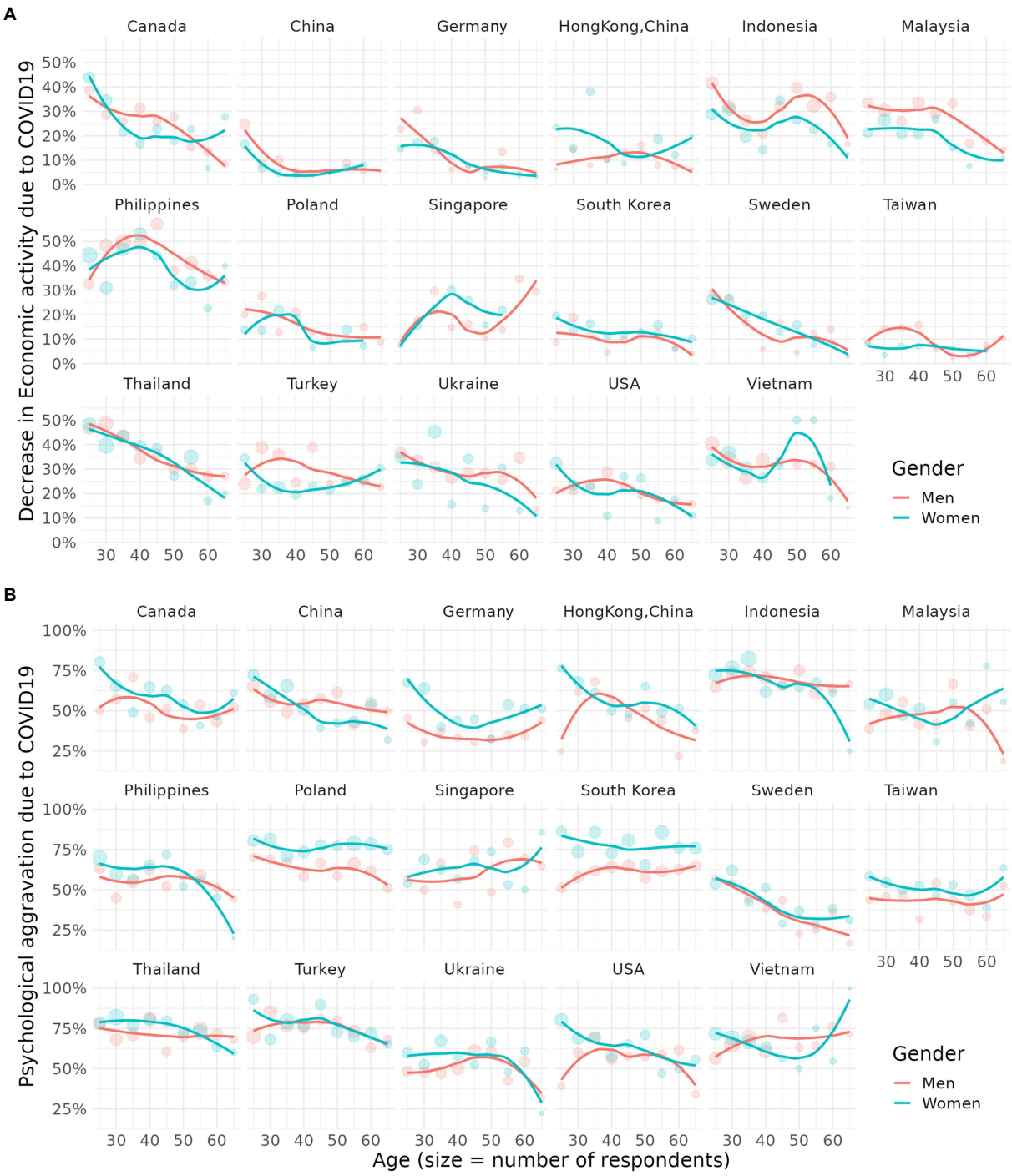


FIGURE 2
**(A,B)** Proportion of job loss and psychological distress due to COVID-19 stratified by age and gender.

The result of the logistic regression analysis (as OR and 95% CIs) of the association of psychological distress and decrease in economic activity, age, and gender stratified by HDI is shown in Table 1. As this was a mixed model, country and education level were regarded as random factors. For all countries, the ORs (95% CIs) for the depressive or anxious symptoms by decrease in economic activity were 1.101 (1.08–1.123) for economic status loss group, 0.998 (0.997–0.999) for age, and 1.067 (1.051–1.084) for women. Stratified with countries' HDI levels, each group shows the same ORs for psychological distress as 0.998. The associations between women and decrease in economic activity were slightly higher in high HDI level countries as ORs (95% CIs) were 1.108 (1.078–1.138) and 1.137 (1.096–1.180) respectively, than low HDI level countries which were 1.029 (1.007–1.051) and 1.084 (1.058–1.111).

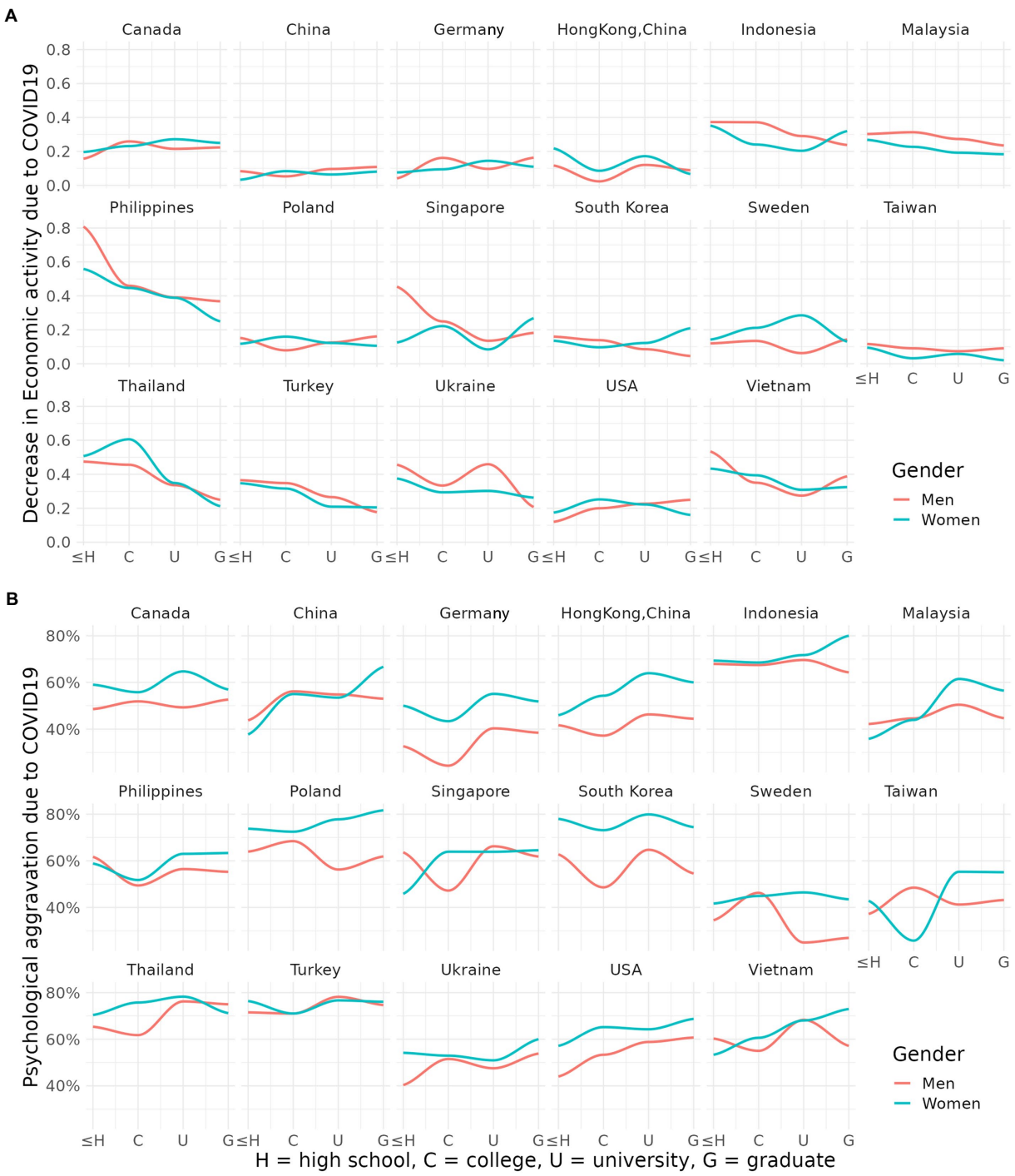


FIGURE 3
**(A,B)** Proportion of job loss and psychological distress due to COVID 19 analyzed by education level.

## 4. Discussion

COVID-19 has caused an economic crisis and numerous job losses worldwide (29, 30). This study investigated the associations among decrease in economic activity, gender, and psychological distress with consideration of economic status of countries and education using multinational surveys. The results revealed that women had a higher prevalence of psychological distress than men, and younger age was significantly associated with decrease in economic activity. Moreover, countries with lower HDI showed a higher prevalence of decrease in economic activity, especially at lower education levels. Psychological distress due to COVID-19 shows significant associations with decrease in economic activity, women, and younger age. While the proportion of decrease in economic activity was different for each country, the degree of association of the individual factors was the same. These results show consistency with

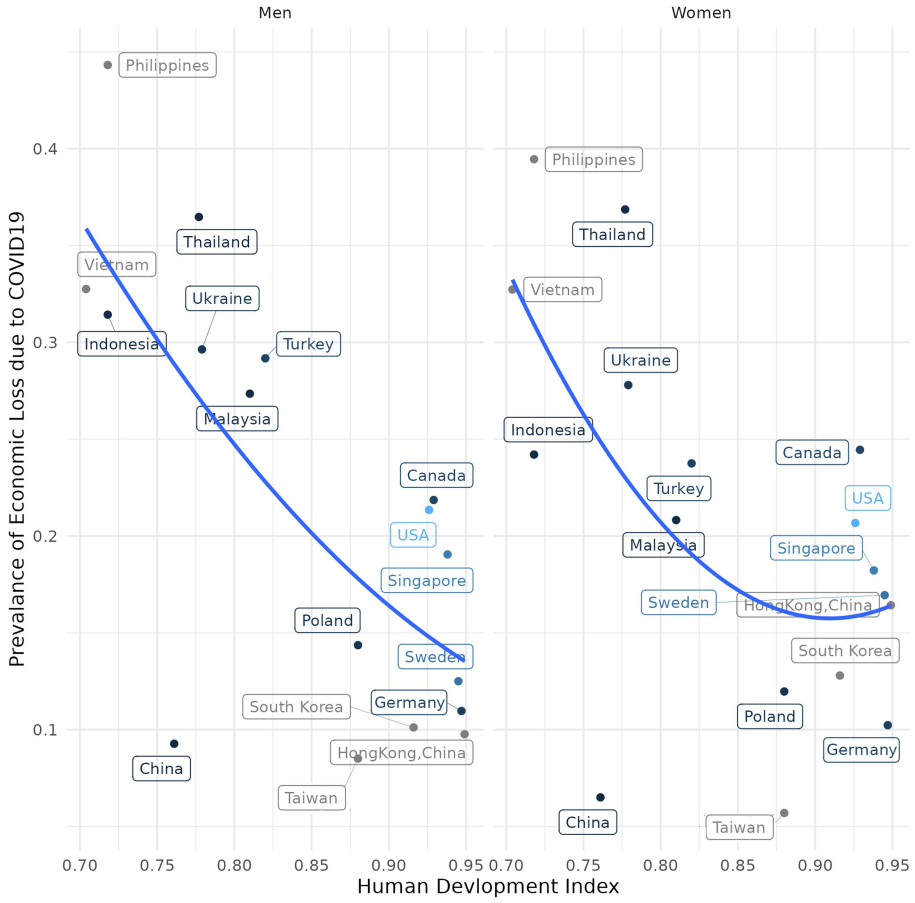


FIGURE 4
Human development Index versus job loss due to COVID-19 stratified by gender.

other studies, especially showing exacerbation in women. Also, some studies have shown that specific nation's demographic groups suffered disparities in the workforce, according to skin color and immigrant status (31, 32). In these 15 countries, the association between gender and unemployment rate varies from country to country. In Hong Kong, where women have a significant unemployment rate relative to men, the ratio of female to male labor force participation rate was 79.58% in 2019. In Malaysia (2020) and Indonesia (2021), which shows significant higher decrease in economic activity for men, the ratio of female to male labor force participation rate was 68.6 and 65.3%, respectively (33). Therefore, this gender difference in decrease in economic activity may be due to differences in labor force participation. Moreover, Dang and Nguyen announced that women expected their labor income to fall by 50% more than men, which might affect psychological distress (31). Gender difference in the participation rate can be attributed to the fact that women were more likely to work in fields which required face-to-face contact. Thus, this situation may have been impacted by social distancing guidelines (31, 34).

Decrease in economic activity was also related to younger age and psychological distress. This result corresponds to research stating that the COVID-19 recession hit young workers the hardest since February 2020 in the United States (35). Moreover, Major et al. reported that those between 16 and 25 years were twice as likely as older employees to have suffered decrease in economic activity due to the COVID-19 (36). Several explanations were offered. For instance, younger employees may have been predominantly employed in industries that were the hardest hit, such as service and sales, hospitality and leisure, and retail trade (14). Therefore, higher decrease in economic activities in younger workers compared to older counterparts may account for the participation rate gap in the retail trade, leisure, and hospitality industry (37). Furthermore, young workers have been excluded from certain COVID-19 assistance in several countries (37).

Education level and decrease in economic activity were negatively correlated in some countries with low HDI. This supports the idea that the labor market disruptions have affected workers in a wide set of industries and occupations, and those without a college degree experienced the most severe impacts (38). Addressing gaps in educational attainment might be important to create better economic resiliency for individuals against future emergent circumstances.

Even though decrease in economic activity in low education level participants was higher, countries such as the Philippines, Thailand, and Turkey did not show distinct psychological distress difference between education groups. A possible explanation can be made that this reflects a "steeling effect" among lower HDI populations with lower education levels. They have probably experienced past adversity, and therefore, acquired more resilience for dealing with sudden negative experiences (39).


FIGURE 5
Correlation analysis plot of study variables.

HDI and prevalence of decrease in economic activity due to COVID-19 have a negative association in both men and women. Lee and Chang examined the relationship between the tourism sector and growth of the economy (40). The result affirmed that tourism development has a greater impact on gross domestic product (GDP) in non-Organization for Economic Cooperation and Development (OECD) countries than in OECD countries, which implies that countries dependent on tourism with lower HDI might be affected more by the COVID-19 recession. Moreover, individuals working in tourism industries show relatively low education levels compared with workers in general (41).

Furthermore, the proportion of travel and tourism industry field among the global GDP decreased to 5.5% in 2020 from 10.4% of 2019 (42). This decline over the previous year was because of the COVID-19 pandemic which disrupted worldwide travel (42). Therefore, we reason that COVID-19 worsened the economic situation of low HDI-scoring countries by impacting the tourism industry and thereby the increasing the decrease in economic activity of workers at a lower education level.

Unemployment disproportionately affects the economically vulnerable, raising concerns about worsening social inequality. Given the high prevalence of unemployment among women and young workers, there is an urgent need to improve the availability and affordability of mental health services, as well as the need for financial aid and job creation programs for them. Psychological interventions and economical support alone cannot directly solve the underlying problem of decrease in economic activity; however, they might help an individual stay confident and motivated to persevere with job searching when the economy rebounds. In addition, it might be possible to provide not only wage compensation, but also skills training or job relocation. Such measures could help rebuild the careers of lower education workers in low HDI countries, especially in the tourism industry (43).

TABLE 1 Associations between psychological distress and HDI, economic status, age, gender.

| HDI | Predictors | | OR | LL | UL |
|---|---|---|---|---|---|
| All | *Economic status* | *Active* | *1* | *(Reference)* | |
| | | *Loss* | 1.101 | 1.08 | 1.123 |
| | Age | | 0.998 | 0.997 | 0.999 |
| | Gender | Men | *1* | *(Reference)* | |
| | | Women | 1.067 | 1.051 | 1.084 |
| >0.9 | *Economic status* | *Active* | *1* | *(Reference)* | |
| | | *Loss* | 1.137 | 1.096 | 1.180 |
| | Age | | 0.998 | 0.996 | 0.999 |
| | Gender | Men | *1* | *(Reference)* | |
| | | Women | 1.108 | 1.078 | 1.138 |
| >0.8 | *Economic status* | *Active* | *1* | *(Reference)* | |
| | | *Loss* | 1.086 | 1.042 | 1.133 |
| | Age | | 0.998 | 0.997 | 1 |
| | Gender | Men | *1* | *(Reference)* | |
| | | Women | 1.075 | 1.042 | 1.11 |
| <0.8 | *Economic status* | *Active* | *1* | *(Reference)* | |
| | | *Loss* | 1.084 | 1.058 | 1.111 |
| | Age | | 0.998 | 0.997 | 0.999 |
| | Gender | Men | *1* | *(Reference)* | |
| | | Women | 1.029 | 1.007 | 1.051 |

Mixed Model: country and education are regarded as random effect.

## 5. Strength

There are several strengths in our study. The COVID-19 pandemic provides a unique opportunity for analyzing the implications of unemployment for mental health as the cause of decrease in economic activity is exogenous to individuals. In addition, decrease in economic activity related to national lockdown reflects characteristics such as national countermeasures, outbreaks, and economic structure under the same conditions between countries, which provide the settings for a natural experiment. Studies on the COVID-19 scenario have usually focused on macroeconomic statuses such as GDP. In this study, individual psychological factors were directly related with decrease in economic activity. Unlike previous research that has limited data from limited countries and regions, this research is one of the few papers that looked at the psychological problem of COVID at the multinational level. A total of 15 countries participated in this study, which facilitated comparisons between countries with a large sample size ($n = 14{,}243$). Therefore, this study might be used as a cornerstone to set policies for the vulnerables who need financial support and psychological intervention.

## 6. Limitation

However, this study has several limitations. First, as it used a cross-sectional, correlational design, this study cannot be used to clarify whether decrease in economic activity precedes the psychological symptom or occurs as a result of certain behaviors by worker who are already depressed or anxious. Therefore, additional longitudinal investigations are needed. Second, there is a lack of information about confounding factors, which may be related to psychological symptoms other than decrease in economic activity. For instance, study participants may have a history of depression, anxiety disorder, sleep disturbance, and drug use. Moreover, social distancing due to COVID-19 might affect the mental health of study participants directly; this issue should be considered in future studies. Another drawback is that the reliability of data obtained through online self-information research is not guaranteed. Finally, as the defining psychological symptom was based on one question, it does not ensure questionnaire validity and is less sensitive to variation in, or the severity of, psychological symptoms as opposed to more comprehensive tools such as the Patient Health Questionnaire-9 (PHQ-9) and the Center for Epidemiological Studies-Depression Scale (CES-D) 10. As cross-sectional study correlation between SAR-CoV-2 variants and COVID-19 variants cannot be described.

## 7. Conclusion

Our study showed that decrease in economic activity, younger age, and being women were significantly associated with psychological distress. Moreover, women in higher HDI countries and lower education levels in lower HDI countries were considered vulnerable. Therefore, improved policies and guidelines for relevant financial aid and psychological intervention are needed, especially for the vulnerable populations.

## 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 authors.

## Author contributions

MK: conceptualization, resources, data curation, formal analysis, investigation, visualization, methodology, writing—original draft. BY: conceptualization, investigation, writing—review and editing. JS, AC, and JO: funding acquisition, project administration. JK: data curation. KN: investigation, resources. LR: supervision, investigation, resources, validation. J-HY: supervision, resources, investigation, validation, writing—review and editing. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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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.2023.1056768/full#supplementary-material

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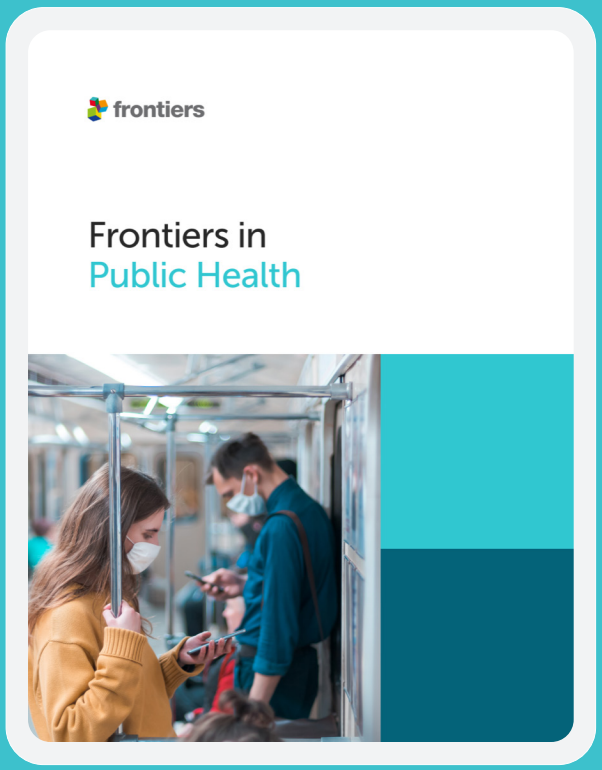


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