PUBLIC HEALTH PROMOTION IN UNIVERSITY STUDENTS

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PUBLIC HEALTH PROMOTION IN UNIVERSITY STUDENTS

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Table of Contents

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Editorial: Public health promotion in university students

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Editorial on the Research Topic
Public health promotion in university students

Introduction

According to the World Health Organization, health is a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity. It is further described as "a resource for everyday life" which is created and experienced by people within the settings of their everyday life: where they learn, work, play, and love (1). This emphasizes the interconnectedness between individuals and their environments. One important setting of everyday life for health promotion is universities. Here, the collective of university students is particularly relevant, since they are the leaders, decision-makers, and parents of tomorrow (2). Therefore, promoting the health of university students could be sustainable and beneficial for the general society. In addition, a students' entrance into this new living environment frequently causes significant changes in the home, work, and recreational environment (3). Furthermore, according to numerous studies, the time of young adulthood (18–25 years) has been characterized as a critical period where people are potentially vulnerable for engaging in risky health behaviors such as drinking, drug use or physical inactivity (4).

Although a large number of studies has been performed in this field, there are still under investigated topics which need more attention. For example, according to a systematic umbrella review by our group, including 81 systematic reviews and meta-analyses, mental health, and alcohol consumption are well-investigated among university students, whereas studies on topics such as sleep hygiene or media consumption are rare (5). Furthermore, the COVID-19 pandemic led to drastic changes in university student's life and conditions of studying. For example, closing of universities led to an abrupt loss of personal contacts with peers and faculty, postponement of curricula, research, practical work, and exchange programs (6, 7). In addition, the abrupt and often

ill-prepared switch to online learning may have led to stress among students (8). Finally, the loss of temporary jobs due to pandemic-related reasons could have compounded financial uncertainties (9).

Therefore, the aim of the current Research Topic is to address these gaps and to provide a Research Topic of up-to-date and high quality research papers focusing on the effects of health-promoting interventions as well as the epidemiology of health (not limited to health behavior only) in university students with focus on, but not limited to, the topics of media consumption, sleep hygiene, nutrition, physical inactivity, sedentary behavior, mental health, and the effect of the COVID-19 pandemic on university students life and health. In order to develop and implement evidence-based health-promoting interventions, it is further necessary to investigate potential correlates (factors that are associated with) or determinants (factors with a causal relationship) of health and health behavior.

Content of the Research Topic

Overall, 22 papers were submitted to the Research Topic of which 14 were accepted for publication after review process (rejection rate: 36%). Four papers referred to health aspects during the COVID-19 pandemic. Schäfer et al. investigated health information seeking among university students before and during the pandemic taking cross-sectional as well as longitudinal data form two online surveys conducted in Germany into account. Furthermore, Defeyter et al. and Matos Fialho et al. focused in their empirical studies conducted in UK higher education students and university students in Germany on mental wellbeing during the pandemic. Both came to the conclusion that a significant proportion of university students faced low levels of mental wellbeing during the pandemic, underlining the need for universities to provide intervention strategies targeting students' mental wellbeing during the pandemic. Finally, Dietz et al. compared the prevalence of pharmacological neuroenhancement (PN) among university students in Germany before and during the pandemic analyzing three consecutive cross-sectional survey studies (one before, two during the pandemic). Although the prevalence slightly decreased during the pandemic, they concluded that the fairly high prevalence of PN of around 8% in 2021 demonstrates a persistent urgent need for prevention initiatives to combat the use of PN among university students.

The remaining 10 papers had no specific COVID-19 focus. Within their conceptual paper, Reichel et al. provided an example on how to conduct a health survey at a large campus university in Germany highlighting potential pitfalls and presenting practical recommendations for future empirical studies. Four studies investigated aspects of specific health-related behavior, three with focus on drug use. Franke et al. showed in an online survey among German students that nearly all students use over-the-counter substances such as coffee, caffeinated drinks, energy drinks, and caffeine pills for enhancing their cognitive performance, whereas the use of illegal and prescription substances for this purpose was only 1.8%. By performing a cluster-controlled trial conducted at eight universities in Germany, Pischke et al. showed beneficial effects of a web-based social norms-intervention on alcohol and cannabis use but no intervention effects on tobacco use and episodes of drunkenness. Comparable results were presented by Wolter et al. who concluded that personalized, gender-specific, and selective normative feedback is effective for alcohol prevention among university students. Furthermore, Edelmann et al. assessed physical activity and sedentary behavior in a sample of university students in Germany and performed subgroup-analyses with regard to gender, age, field of study, targeted degree, and study semester to identify student populations with a potential higher risk for decreased physical activity and increased sedentary behavior levels.

Using longitudinal data from three surveys conducted in university students in Germany, Gusy et al. showed that time pressure predicted burnout which, in turn, predicted student's health-related loss of productivity. The paper from Limarutti et al. put specifically 1st year students from an Austrian University of Applied Sciences into focus by evaluating a tailored multi-component onboarding intervention program. They underline the relevance of starting initiatives to promote students' health early at the beginning of studies and the role of students as future multipliers for health promotion and prevention. Two papers had a closer look at structural conditions of the institution university. Using network analysis, Bachert et al. provided in-depth insights into university structures promoting students' health comprising 33 organizational units. They concluded that in the health-promoting network, numerous opportunities for further integration and interaction of health actors would exist at universities. Kellner et al. introduced the "house of studyability" which may be used as an orientation in the development of processes and sustainable structures. Last but not least, a systematic review including 21 studies by Kühn et al. provided an overview of studies examining health literacy among university students. The majority of studies reported health literacy scores among university students were lower compared to reference samples.

Conclusion

The papers of this Research Topic cover a wide range of topics around university students' health including empirical,

methodological, and conceptual papers, studies evaluating health promotion interventions as well as a systematic review. However, most of the included studies are from German or European research groups what may be due to the fact that potential contributing authors were contacted using the personal network of the handling editors of this Research Topic. Although the results of this Research Topic might have limited generalizability from a global perspective, the contributions address the lack of research in this research field in most European countries as concluded in a recent systematic umbrella review (5). In order to gain a balanced global view in public health promotion in university students, future contributions focusing on to previously underrepresented regions are desirable.

Author contributions

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

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Conflict of interest

The authors declare that the editorial 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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Health Information Seeking Among University Students Before and During the Corona Crisis—Findings From Germany

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Health information-seeking behavior is the process of gathering information about health and disease and can be influential for health-related perception and behavior. University students are an important target group for prevention and health promotion and largely belong to an age group that is considered to play a leading role in propagating the SARS-CoV-2 epidemic in Germany. The paper deals with students' health information-seeking behavior before and during the corona crisis, aiming to give insights into its determinants and implications. Using the example of a large German comprehensive university and based on two cross-sectional surveys in the summer of 2019 ($n = 4{,}351$) and 2020 ($n = 3{,}066$), we investigate which information channels students use for health information, how information seeking changes during the course of the pandemic, and to what extent information seeking is associated with risk perception and risk behavior. For a subsample of participants that participated in both surveys ($n = 443$), we also trace developments at the individual level through a longitudinal analysis. The results show that students' health information seeking takes place primarily online and changed markedly during the corona crisis. The comparatively high relevance of sources that are largely based on unchecked user-generated content raises the concern whether students' health information-seeking behavior guarantees the necessary quality and reliability of health information. Significant correlations between the intensity of corona-related information seeking, risk perception, and actual risk behavior were found.

Keywords: health information seeking, university students, COVID-19, SARS-CoV-2, risk perception, risk behavior

INTRODUCTION

The ongoing pandemic of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has caused more than 300,000 detected cases of coronavirus disease 2019 (COVID-19) illness in Germany and claimed more than 9,500 lives as of October 2020 (1). While deaths related to COVID-19 are relatively rare in younger age groups in Germany, a sizable share of COVID-19-

related hospitalizations also occurs in individuals of those age groups (2). Furthermore, during the first period of outbreaks in spring 2020, scholars identified that individuals aged 20 to 24 years play a leading role in propagating the SARS-CoV-2 epidemic in Germany (2), suggesting that university students, most of whom fall into this age group, play an important role in SARS-CoV-2 transmission. Additionally, in the course of the second wave of outbreaks in summer and autumn 2020, among those people infected, individuals of the younger age group were largely overrepresented (1).

Viral transmission is dependent on human behavior (3). Hence, the health-related behavior of university students is of high relevance (4, 5). The approximately three million students in Germany are, on average, 23.4 years old. More than 84% of the students are aged between 20 and 29 years old (6–8). Against the background of this age distribution, students are a particularly important target group for prevention and health promotion during the ongoing SARS-CoV-2 pandemic, given that the university setting, including teaching and learning environments with full lecture halls and changing group compositions, dormitories, and campus vibrant social life, is potentially associated with an increased risk of infection.

To address students' health risk behavior by measures of prevention and health promotion, it is especially important to assess the factors leading to this behavior, including the reasons for a possible lesser adherence to contact and physical distancing guidelines. Health information seeking and media use are considered to be such factors (9). Studies show that the way people, governments, and media communicate about health issues and health risks and how it is perceived by recipients could also be influential for perceptions, attitudes, and actual behavior in a pandemic situation (3, 10–14).

Health information-seeking behavior is the process of gathering information about health and disease (15). Representative surveys dealing with health information seeking in Germany show that media reporting is one of the most important sources of health information (16–18). These general findings are confirmed for younger age groups (9) and for the information-seeking behavior of the general population during the corona crisis (19). Between March and June 2020, 59 to 76% of the people in Germany stated that they sought information about the topic "very or rather frequently" (20) and, for this purpose, relied on mass media reporting almost daily (21).

Empirical data on the health information seeking of university students (in general as well as in particular in the corona crisis) is relevant for two main reasons: a) to identify potential health risks and health benefits of media use for this target group (and groups related to them) and b) to identify which channels are most suitable for addressing students when applying prevention and health promotion strategies. However, surveys focusing on student life and/or student health often do not take information seeking and media use into account (22). This is why rather little is known about the health information seeking of German university students in either a general or pandemic situation.

This paper investigates students' health information seeking and health-related media use before and during the corona crisis to obtain insights into German university students' behavior and its determinants and implications. Using the example of a large German comprehensive university and based on two cross-sectional surveys in the summer semesters of 2019 (n = 4,351) and 2020 (n = 3,066) as well as a longitudinal analysis of a subsample (n = 443) at the individual level, we investigate which channels university students use to obtain health information, how information seeking changes during the course of a pandemic situation, and to what extent information seeking is associated with risk perception and risk behavior.

THE ROLE OF HEALTH INFORMATION SEEKING IN RISK PERCEPTION

In general, people tend to claim to be less subjected to (health) risks than others, with people's risk perception being more realistic when they already have some direct or indirect experience (23). Beyond that, several other factors influence risk perception and risk behavior, such as real risk, risk sensitivity, perceived control, individual characteristics, attitudes, and media exposure (23–25). Some factors might be particularly influential for the social group of university students and/or in the context of pandemics in particular. For example, Cruwys et al. (11) assumed that shared group membership, mediated through an increased trust in other members and a reduced disgust toward these members and their behavior, leads to a decrease in risk perception and increased risk taking. Accordingly, potential threats arising from ingroup members are perceived as less risky and lead to greater risk-taking behavior than potential threats arising from outgroup members, which can consequently result in an accelerated spread of an infectious disease such as COVID-19 in the course of a pandemic (10, 11).

This general tendency could have important implications with regard to students who form a quite homogeneous group in terms of age, education, and socialization. It seems plausible that students might perceive social interactions with their peers on campus and in their private life as less risky than it actually is, potentially explaining, at least in part, why this particular group might have played a leading role in fueling the SARS-CoV-2 epidemic in Germany (2). This tendency would be in line with findings showing that young adults consider themselves comparatively invulnerable and do not think of health as an important criterion for their behavior, since they perceive themselves as healthy and have hardly any experience of illness, neither themselves nor in their peer group (26).

These tendencies could even be reinforced (or, in the better case, weakened) by a similar health information-seeking behavior within the group. In general, the need for a closer look at information seeking results from the possible effects on perceptions, attitudes, and behaviors that can emanate from the content received (27). This content can have an impact on, for example, the perception of social (health) risks and of personal (health) risks (25). Media content is particularly considered not only to influence which topics people think about and which they think are important (28), but also how recipients perceive and evaluate certain information and issues (29) and how they may

act (30, 31). Following the assumptions of the cultivation theory (32–34), exposure to media content results in the formation of perceptions and beliefs about the social reality that are consistent with the media's portrayals of reality (and therefore possibly inconsistent with reality). The influence of media is greater the less recipients can rely on their experiences or the experiences of their social environment, which, on the one hand, applies to experiences of illness in young adults in general (26) and, on the other hand, applies particularly to the early stage of a pandemic when there are no reported cases in the direct social environment, especially as long as the outbreaks take place in foreign cities and countries.

Trends in general media use (19, 35), as well as findings suggesting that young people are more open to new media and technologies (15, 19, 36, 37), indicate that the health information seeking of students might differ markedly from that of other target groups. Looking at general media use in Germany in the most relevant age groups under 30, online media are by far the most important (35). There is hardly any structural difference between (daily) online users and the general population in these age groups. Furthermore, a representative survey of German Internet users on health information seeking shows that online media is used to a greater extent by the relevant age groups for health-related purposes (9). Social media seems to be relatively important as health-related information sources in general and for the coronavirus in particular, especially in younger age groups (19). In light of international findings showing a high relevance of online information sources among college students (15), it is therefore highly likely that for German university students in particular, online media might be an important source of health information.

Surveys of the general population show that media use changed significantly during the corona crisis (19). Health-relevant effects of media use on perceptions, attitudes, and behavioral intentions have also been reported in the context of pandemics. In the ongoing SARS-CoV-2 pandemic, researchers found that patients more frequently described symptoms of a loss of smell or taste when media had previously reported on them (38). During the H1N1 pandemic 2009/2010, for example, a lack of trust in media reporting resulting from a perceived low quality of media coverage was associated with lower vaccination intentions (39). Not only but even more particularly during pandemics, media use is therefore considered to have a more or less important influence on health-related risk perception and risk behavior (12, 14, 24, 25, 40).

Considering the potential important role of university students as a target group for health prevention and health promotion in general as well as during the ongoing pandemic in particular, the possible changes of information seeking during a pandemic crisis, and the possible influences of information seeking for risk perception and risk behavior, the present study asks:

1) Which channels do university students use for health information?
2) How does information seeking change in the course of a pandemic situation?
3) To what extent is information seeking associated with risk perception and risk behavior during a pandemic situation?

METHODS

To address students' information-seeking behavior and its implications for risk perception and risk behavior during the corona crisis, we conducted two online surveys in summer 2019 and 2020 at a large German comprehensive university (about 31,500 students) with a full range of disciplines and subjects, located in a German mid-size city (about 210,000 inhabitants). Both surveys were conducted as part of an ongoing evidence-based student health initiative in a 2 year interval, which involves detailed surveys of the student body regarding important health-related factors (around 270 items, mostly validated standard instruments and partly self-designed or adapted items). However, since living and study conditions suddenly changed so dramatically during the pandemic (and resulted in the abovementioned research questions), we conducted an additional survey within this acute pandemic situation amending self-designed COVID-related items.

Recruitment was accomplished in both cases by an email that was sent to all students currently enrolled at the university. Students received this email in their accounts where they normally received important notifications (e.g., about their grades). The emails were tailored to the target group and emphasized different monetary and non-monetary incentives to increase motivation for participation. Reminder emails were sent at different times.

Participants had to be enrolled in at least one subject of study at the local university. Answering at least one relevant question regarding relevant health variables such as health information seeking (in addition to demographic variables) was a prerequisite to be included for further analyses.

Approval to perform the studies was obtained by the ethical committees of the Medical Association of Rhineland-Palatinate (study I: No. 2019-14336) and the Institute of Psychology of Johannes Gutenberg University Mainz (study II: No. 2020-JGU-psychEK-S008). Both studies were designed as cross-sectional surveys. Nevertheless, the repeated measurement of certain items over time allows at least for some participants, to some extent, statements not only on a macro level but also on an individual level, as at the beginning of each survey the respondents created an individualized unique anonymous code that allowed a comparison of the results for respondents participating in both surveys. For a subsample of students that participated in both surveys ($n = 443$), we could therefore trace certain developments at an individual level.

We surveyed the frequency of health information seeking and the sources and channels used for this purpose. To measure the frequency of information seeking, participants were asked how frequently they have "sought information on health and disease in the past 12 months?" (study I) and "sought information on this topic in recent weeks?" (study II), respectively. Answer options were "never," "less than once a month," "at least once a month," "at least once a week," and "at least once a day." Additionally, we

TABLE 1 | Mean age and distribution of gender in the sample, the university student population, and the student population in Germany in percent.

	Study I (n = 4,351)	**Study II (n = 3,066)**	**Subsample I/II (n = 443)**	**University (n = 31,500)**	**Germany (n = 2.9 million)**
Age	23.8 (mean)	23.4 (mean)	22.8/23.7 (mean)	24.7 (mean)	23.4 (median)
Gender					
Male	28.6	26.8	22.6	41.0	51.1
Female	70.5	72.6	77.0	59.0	48.9
Diverse	0.9	0.7	0.5	–	–

recorded the frequency of information seeking in days per week (0–7; less than at least once a week = 0; at least once a day = 7; participants who stated to have sought information at least once a week were asked to indicate the exact number of days per week).

To record the sources of information, we asked the participants where they have sought information "on health and disease in the past 12 months" (study I) and "on the coronavirus during recent weeks" (study II), respectively. In a first step, participants could indicate whether they have used certain information sources (e.g., interpersonal sources, e.g., family members, friends, and colleagues; health professionals; pharmacists; other patients; mass media sources, e.g., offline mass media, online media) or not. Multiple answers were possible. In a second step, participants who indicated to have used online sources were asked which online sources they have used "for information on health and diseases" (study I) and "to obtain information about the coronavirus?" (study II), respectively. Participants could indicate whether they have used certain online sources (e.g., websites of health organizations, doctors or health insurance companies, journalistic online news sites, blogs on health and disease, social media, video platforms, online encyclopedia like Wikipedia or search engines like Google) or not. Again, multiple answers were possible.

As possible determinants, we surveyed different demographics such as age, gender, the intended degree as well as health interest, health literacy, and health status (e.g., perceived health condition, presence of a chronic disease) of students. Health interest was measured on a five-point Likert scale from "not interested at all" to "very interested"[1]. Health literacy was recorded on a four-point scale ("very easy," "fairly easy," "fairly difficult," "very difficult") with the help of a short version of the of the German Health Literacy Questionnaire (HLS-GER), including four items ["How easy/difficult would you say it is to…" a) "find information about symptoms of illnesses that concern you?"; b) "understand what to do in a medical emergency?"; c) "judge when you need to go to a doctor for a check-up?"; and d) "make decisions to improve your health?"; sum score including all four single items: 0–12]. Participants rated their perceived health condition on a scale ranging from 0 = "worst conceivable state of health" to 10 = "best conceivable state of health." They further indicated if they have been diagnosed with a chronic disease or not.

The questionnaire of the second survey included additional questions on risk perception, risk behavior, general vaccination motivation, and specific vaccination intentions that could be influential during a pandemic situation. Regarding risk perception, we asked the students to indicate on a seven-point scale from "not at all likely" to "absolutely likely" how likely it was in their opinion that within a 2 month time frame (a) they get infected with the coronavirus; (b) their family members, friends, and colleagues get infected with the coronavirus; (c) they need hospitalization in case of an infection; (d) they are quarantined, regardless of an infection; and (e) they get infected and infect others with the virus. To measure risk behavior, participants indicated if they did comply with the five central recommendations of health authorities (to wash hands often and intensely; to use antiseptics; to reduce meetings and personal contacts; to wear a mask; to avoid crowded places) in the week before the survey or not. A sum score (0–5) was calculated. General vaccination motivation was recorded by a single item ["How important is it for you to have sufficient vaccination protection against common diseases (e.g., mumps, measles, rubella, tetanus)?"] on a five-point Likert scale from "not at all important" to "very important." We further asked the students how likely they would get vaccinated if a vaccine against the coronavirus was available. They could scale their answer on an 11-point Likert scale from "very unlikely" to "very likely."

Study I was conducted in June and July 2019 during a regular semester[2] with classroom teaching and physical presence on the university campus. In total, 4,351 university students participated in the survey, demonstrating a response rate of 13.9% of the total student population at that time. Compared with the distribution of the university, female and younger students were overrepresented in the sample (**Table 1**).

Of the participants, 52% were studying for a bachelor's degree and 21.1% for a master's degree. Another 22.5% were aiming for a German state exam (e.g., law and medical students, students of teaching professions), and 3.4% were Ph.D. students. While 92% of the participants were born in Germany, 24% had at least one parent with a migration history.

The participants were highly interested in the topic of health and disease and considered their own health status to be relatively good (**Table 2**). Female participants were slightly more interested

[1]Question: "Some people are particularly interested in the topic of health and disease, others not at all. How about you: How interested are you in the topic?"

[2]The academic year at most German universities is divided in two terms: a winter semester, usually starting mid-October, and a summer semester, starting in mid-April.

TABLE 2 | Interest in health and perceived health status of the participants by gender.

Measure	Total	Male	Female	Diverse
Interest in health and disease[a]	4.0	3.9	4.1	3.5
Perceived health status[b]	7.4	7.5	7.4	6.3

n = 4,351.

[a]*Question: "Some people are particularly interested in the topic of health and disease, others not at all. What about you? How interested are you in the topic?" (1 = not at all interested; 5 = very interested).*

[b]*Question: "If you rate the best conceivable state of health with a 10 and the worst conceivable state of health with a 0, how many points do you give for your current state of health?"*

TABLE 3 | Frequency of health information seeking.

Frequency of information seeking	Study I %	Study II %
Never	1.2	0.6
Less than once a month	19.3	4.0
At least once a month	38.5	12.6
At least once a week	30.2	54.6
At least once a day	10.9	28.1

$\chi^2 = 1{,}309.48$, $p < 0.001$; study I: n = 4,347; Question: "How frequently have you sought information on health and disease in the past 12 months?"; study II: n = 2,994; Question: "Some people seek information on the coronavirus on a daily basis, while others never seek such information. We are interested in how you deal with it. How frequently have you sought information on this topic in recent weeks?"

in health and disease and reported a slightly lower health status than male participants. Participants who identified themselves as diverse stated a significantly lower interest in the topic and a significantly poorer health condition.

The existence of SARS-CoV-2 was first confirmed in China at the end of December 2019, and there are indications of a spread within Europe from December 2019 (41). In Germany, the first cases of COVID-19 diseases were reported in January 2020. By mid-July 2020, Germany detected almost 200,000 confirmed cases (42). At that time, the share of hospitalizations among the detected cases was about 17%, and the share of deaths was 4.6% (42, 43). In consequence, during the summer semester of 2020, the life and work of university students in Germany were heavily affected by the first outbreaks of the novel coronavirus and the following emergency situation. The acute pandemic situation resulted in far-reaching measures regarding social and university life to contain the epidemic and a shutdown of nearly all university facilities in Germany right before the start of the summer term in April 2020. Emergency operation was guaranteed at most German universities and resulted in the exceptional situation of almost exclusively online teaching during the summer semester without any physical presence or social activities at the universities allowed.

Study II was conducted in June and July 2020, at the heart of this pandemic situation. Overall, 3,066 students participated in our survey, demonstrating a response rate of 9.7% of the total student population at that time. The sociodemographic structure of the sample was like that of the first study. Therefore, 56% of the participants were aiming for a bachelor's degree, 21% for a master's degree, 21.6% were aiming for a German state exam (e.g., law and medical students, students of teaching professions), and 0.4% were Ph.D. students. Compared with the distribution of the university, female and younger students were again overrepresented in the sample (**Table 1**).

There were some notable differences regarding students' rooming situation between study I and study II that came along with the pandemic. At the time of study II, 37.1% lived with their parents or other relatives (study I: 21.6%), 10.5% lived in a student dormitory (study I: 15.7%), another 11.3% lived alone in an apartment (study I: 15.5%), 20.2% shared their apartment with their partner and/or children (study I: 19.7%), and 20.9% lived with roommates of a shared apartment (study I: 27.4%). Of the students in our sample, 0.5% indicated to have already been infected with the coronavirus.

For a subsample of students that participated in both surveys ($n = 443$), we traced developments at the individual level. Those students were significantly younger at the time of the first survey compared with the general sample of study I (**Table 1**); this was unsurprising because students' age increases as the time of study graduation approaches, which increases the probability for younger students and decreases the probability for older students that they (can) participate in both studies. At the time of the second survey (about) 1 year later, the age distribution in the subsample consequently reflected approximately the age distribution in the main samples of study I and study II. Female students were even more overrepresented in the subsample, accounting for more than three-quarters of all respondents. However, there were no differences regarding general interest in health and disease between the main and subsamples.

All statistical analyses were performed with IBM SPSS, version 23.

RESULTS

Study I

The students in our sample were quite active with regard to their health information-seeking behavior. Of the students, 80% stated that they sought information on health and disease at least once a month, 41% stated that they engaged in health information seeking every week, and 11% every day. Only 1% of the students indicated that they did not seek health information during that respective period, and 19% stated that they sought information less regularly than once a month (**Table 3**).

On average, students sought information on health and disease 1.5 days per week (SD = 2.4). Female students ($M = 1.6$; SD = 2.4) were slightly more active than male students ($M = 1.4$; SD = 2.3) and students who identified themselves as diverse ($M = 1.2$; SD = 2.3), but without statistically significant differences ($F = 1.94$; $p > 0.05$). Bachelor students ($M = 0.9$; SD = 1.6) showed significantly less intensive health-seeking behavior (days per week) than master students ($M = 1.1$; SD = 1.9), Ph.D. students (M = 1.6; SD = 2.6), and students aiming for a German state exam ($M = 3.4$; SD = 3.0) ($F = 153.85$;

$p < 0.001$). Students with chronic diseases ($M = 2.0$; SD = 2.5) sought health information significantly more often than students without such diseases ($M = 1.4$; SD = 2.3) ($t = 6.62$; $p < 0.001$).

General interest in health and disease was positively associated with the intensity of health information seeking ($r = 0.48$; $p < 0.001$), while no such correlation was evident between the perceived health status and health information-seeking behavior ($r = 0.01$; $p > 0.05$). Health literacy was positively associated with the intensity of health information seeking ($r = 0.25$; $p < 0.001$).

Online sources were by far the most important information sources on health and disease for the students[3]. More than 90% reported that they used online media for health information seeking during the 12 months preceding the study. Also quite important were interpersonal contacts with family members, friends, and colleagues (75%) and health professionals (59%). By contrast, the reporting of offline mass media (40%) and personal contacts with pharmacists (20%) or other patients (13%) played a rather subordinate role as sources of health information.

Looking at the concrete online sources that students, who utilized online media for health information seeking, used for information on health and disease, our data show that students accessed health information often *via* search engines (77%; **Figure 1**). The most relevant providers for students' online information on health and disease included Wikipedia or other online encyclopedias (55%), specialized health portals (54%), online news sites (43%), and video platforms like YouTube (34%). Websites of health professionals and health institutions, special blogs on health and disease, social media and health forums, and online forums were frequented by one in four to one in three of the students, while medical online consultations played almost no role.

Study II

The intensity of students' health-related information seeking increased markedly during the corona crisis. More than 95% of the respondents reported that they sought information on the coronavirus at least once a month, 83% stated that they sought information at least every week, and 28% sought information every day. Only 0.6% of the participants indicated that they did not seek information about the coronavirus, and 4% stated that they sought information less regularly than once a month (**Table 3**).

On average, students sought information on the coronavirus 3.6 days per week (SD = 2.6). The intensity of information seeking did not differ significantly between students with ($M = 3.7$; SD = 2.6) and without ($M = 3.6$; SD = 2.6) chronic diseases ($t = 1.39$; $p > 0.05$), as it could have been supposed in consequence of a possible perception to be more vulnerable due to potential risk factors for a severe course of the disease. As in study I, no correlation was evident between perceived health status and information seeking ($r = 0.03$; $p > 0.05$). Health literacy was not positively associated with the intensity of information seeking either ($r = 0.03$; $p > 0.05$), but with the perceived health status ($r = 0.18$; $p < 0.001$). As in study I, no significant differences ($F = 0.51$; $p > 0.5$) were evident between female students ($M = 3.6$; SD = 2.6), male students ($M = 3.7$; SD = 2.6), and students who identified themselves as diverse ($M = 3.4$; SD = 2.7).

Compared with students' general health information-seeking behavior beyond a pandemic situation, interpersonal contacts with family members, friends, and colleagues (81%) became even more important to the students as a source of information during the corona crisis[4]. Notably, the same applied to classic offline mass media reporting (68%), while personal contacts with health professionals (19%), pharmacists (4%), or other patients (4%) were of little importance.

In addition, during the corona crisis, online sources were by far the most important information sources for the students (92%). However, again, decisive shifts in concrete online media use in the context of an acute pandemic situation could be observed (**Figure 1**). On the one hand, there was a clear tendency toward a greater use of journalistic news media. Almost 87% of the students indicated that they had utilized journalistic online news websites for information seeking. Search engines were highly relevant to access information on the coronavirus (62%) but were not used as widely as for health information seeking in general. On the other hand, social media played a much more important role regarding information seeking during the corona crisis. More than half of the students stated that they used social media services, such as Facebook, Instagram, Snapchat, and Twitter, for information seeking. The students also used video platforms (40%), online radio, audio streaming, and podcasts (32%), as well as websites of health organizations (22%), such as the WHO or the Robert Koch Institute (RKI), more intensively. By contrast, online encyclopedias (17%), blogs (8%), and online health forums (7%) played a relatively minor role in students' information seeking on the coronavirus.

Significant correlations existed between the intensity of corona-related information seeking and risk perception and actual risk behavior (**Table 4**). A higher/lower extent of corona-related information seeking was associated with a higher/lower perceived susceptibility to get infected with the new coronavirus and a higher/lower perceived likelihood of needing hospitalization, of infecting others with the virus in case of an infection, of being quarantined regardless of an infection, and of persons in the closer social environment getting infected. In addition, a higher/lower extent of corona-related information seeking went along with a higher/lower compliance with recommendations aimed at containing the spread of the virus (e.g., washing hands often and intensely, using antiseptics, reducing meetings and personal contacts, wearing a mask, and avoiding crowded places), as well as with a higher/lower intention to get vaccinated if a vaccine against the coronavirus were available.

Subsample: Individual Level

Relevant changes in students' information-seeking behavior were also found in the subsample on an individual level, which

[3] $N = 4,345$; Question: "Where have you sought information on health and disease in the past 12 months?"

[4] $N = 2,991$; Question: "Where have you sought information on the coronavirus during recent weeks?"

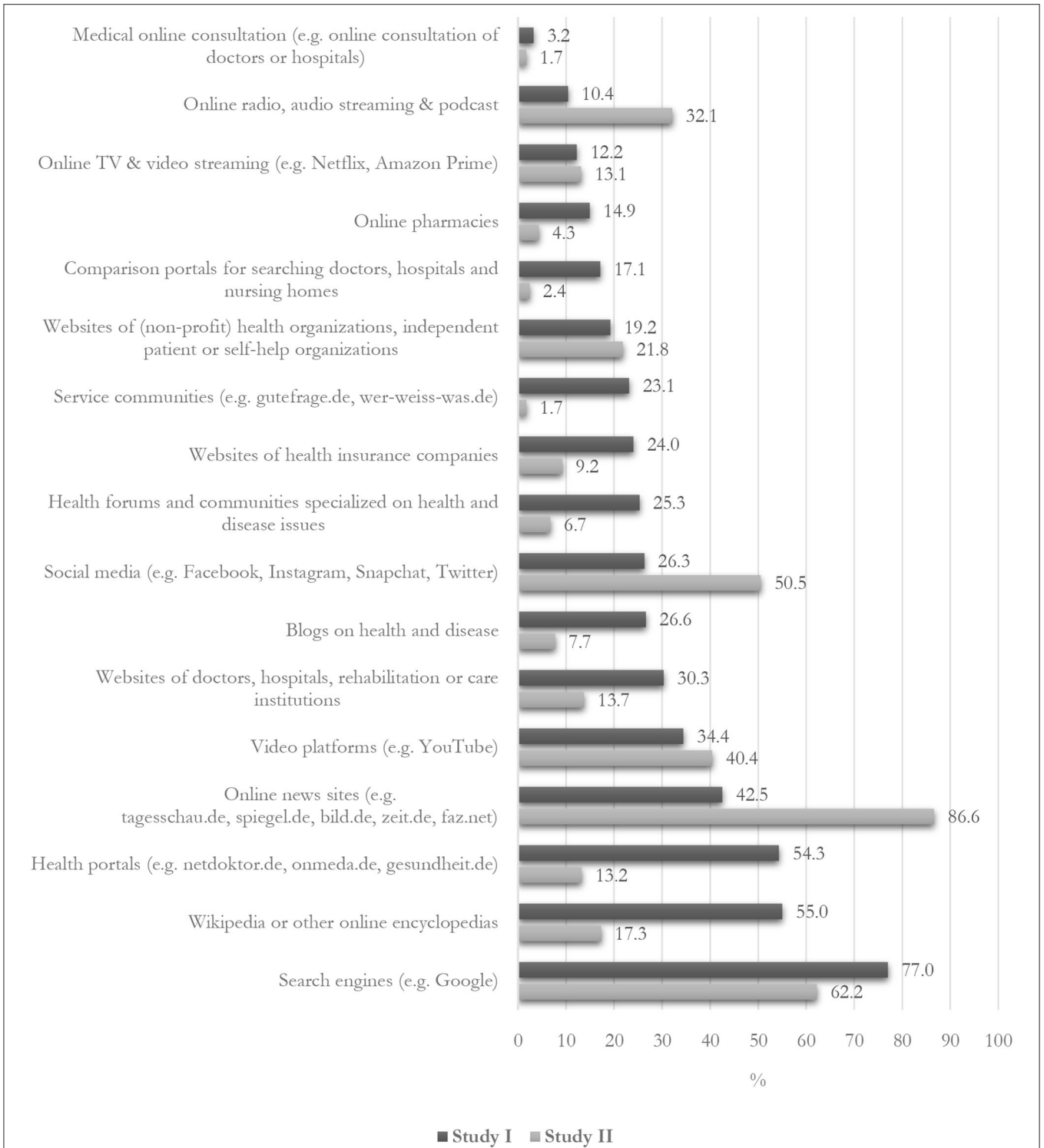

FIGURE 1 | Online sources for information on health and disease (study I) and on coronavirus (study II), respectively. Percentage among participants. Study I: $n = 3,920$; Question: "Which online sources have you used in the past 12 months for information on health and diseases?"; study II: $n = 2,735$; Question: "Which online sources have you used to obtain information about the coronavirus?"; Pearson's chi-square: *medical online consultation*: $\chi^2 = 14.20$, $p < 0.001$; *online radio, audio streaming, and podcast*: $\chi^2 = 484.99$, $p < 0.001$; *online TV and video streaming*: $\chi^2 = 1.02$, $p > 0.05$; *online pharmacies*: $\chi^2 = 191.92$, $p < 0.001$; *comparison portals*: $\chi^2 = 355.07$, $p < 0.001$; *websites of (non-profit) health organizations, independent patient or self-help organizations*: $\chi^2 = 6.51$, $p < 0.05$; *service communities*: $\chi^2 = 603.55$, $p < 0.001$; *websites of health insurance companies:* $\chi^2 = 238.89$, $p < 0.001$; *health forums and communities specialized on*

(Continued)

FIGURE 1 | *health and disease issues:* $\chi^2 = 384.15$, $p < 0.001$; *social media*: $\chi^2 = 405.95$, $p < 0.001$; *blogs on health and disease*: $\chi^2 = 376.12$, $p < 0.001$; *websites of doctors, hospitals, rehabilitation, or care institutions*: $\chi^2 = 244.40$, $p < 0.001$; *video platforms*: $\chi^2 = 24.91$, $p < 0.001$; *online news sites*: $\chi^2 = 1{,}314.98$, $p < 0.001$; *health portals*: $\chi^2 = 1{,}161.57$, $p < 0.001$; *Wikipedia or other online encyclopedias*: $\chi^2 = 955.23$, $p < 0.001$; *search engines*: $\chi^2 = 169.54$, $p < 0.001$.

TABLE 4 | Correlations between the intensity of information seeking on the coronavirus and corona-related risk perception, risk behavior, and vaccination intentions.

Measure	*r*
Risk perception	
Perceived likelihood of getting infected with the coronavirus	0.12***
Perceived likelihood of family members, friends, and colleagues getting infected with the coronavirus	0.10***
Perceived likelihood of needing hospitalization in case of infection	0.06**
Perceived likelihood of being quarantined, regardless of infection	0.13***
Perceived likelihood of getting infected and infecting others with the virus	0.07***
Risk behavior and vaccination intentions	
Compliance with recommendations[a]	0.17***
Vaccination intentions against coronavirus[b]	0.16***

*Pearson's correlation; n = 2,987–2,991; **p < 0.01; ***p < 0.001.*

[a]*Compliance with recommendations to wash hands often and intensely, use antiseptics, reduce meetings and personal contacts, wear a mask, and avoid crowded places in the week before the survey.*

[b]*Question: "How likely would get vaccinated if a vaccine against the coronavirus were available?"*

TABLE 5 | Changes in frequency of health information seeking in the subsample (individual level, T1 and T2).

Frequency of information seeking	T1 (study I) %	T2 (study II) %
Never	0.7	0.2
Less than once a month	19.0	3.7
At least once a month	42.2	11.2
At least once a week	31.2	51.6
At least once a day	7.0	33.3

Subsample: students who participated in both surveys; n = 443; Question T1: "How frequently have you sought information on health and diseases in the past 12 months?"; Question T2: "Some people seek information on the coronavirus on a daily basis, while others never seek such information. We are interested in how you deal with it. How frequently have you sought information on this topic in recent weeks?"

underlines the validity of the observed changes based on the cross-sectional data of study I and study II (**Table 5**). Very similar shifts can be observed. In the first survey, while 19.7% of the students stated that they sought information on health and disease never or less regularly than once a month, only 3.9% maintained this behavior during the corona crisis. Instead, almost 85% stated that they sought information on the coronavirus at least every week, and one-third every day, an increase of 47 and 26 percentage points compared with general health information seeking, respectively. The average frequency of information seeking among the students increased from 1.3 (SD = 2.1) to 4.0 days (SD = 2.6) a week, with statistically significant differences ($t = 18.48$; $p < 0.001$). The intensity of general health information seeking and corona-related information seeking was only moderately correlated ($r = 0.21$; $p < 0.001$), indicating that, although there are certain tendencies related to general habits of the students, many students showed substantial changes in their behavior in the pandemic situation.

The average number of information sources and online information sources used for health-related information seeking varied significantly between the time before and during the corona crisis. While the students used 3.9 different information sources for general health information (SD = 1.7), for corona-related information, they used only 3.2 different sources on average (SD = 1.3; $t = 8.76$; $p < 0.001$). A similar decline was observed for the number of online health information sources, which dropped from an average of 5.3 different sources (SD = 2.7) to 4.0 (SD = 2.1; $t = 8.93$; $p < 0.001$), indicating a more focused use of (certain health-related) information sources during the pandemic.

Different from the cross-sectional sample, there were no or only very small significant correlations regarding the intensity of information seeking, risk perception, and actual risk behavior. A higher/lower extent of corona-related information seeking was slightly associated with a higher/lower perceived likelihood of persons in the closer social environment getting infected ($r = 0.10$; $p < 0.05$), a higher/lower tendency to wash hands often and intensely ($r = 0.11$; $p < 0.05$), a higher/lower general vaccination motivation ($r = 0.15$; $p < 0.01$), and a higher/lower intention to get vaccinated if a vaccine against the coronavirus was available ($r = 0.15$; $p < 0.01$). General health information-seeking behavior (T1) was slightly associated with the perceived likelihood of being quarantined later on (T2; $r = 0.10$; $p < 0.05$). However, in contrast to our cross-sectional data, no other significant correlations between information seeking and risk perception respective risk behavior were found.

DISCUSSION

Our data show that student health information seeking takes place primarily online. The comparatively high relevance of search engines and sources, which are largely based on user-generated content, raises the question of whether students' health information-seeking behavior guarantees the necessary quality and reliability of health information, knowing that wrong and erroneous information can lead to serious health-related consequences. In our view, there is a need for further research in this area on the one hand, and a clear potential for education campaigns in the university context that focus on the quality and seriousness of online health information and students' health literacy on the other. In turn, for health professionals and health authorities that deal with students' health and health behavior, these findings make clear that it makes sense not to ignore

but instead actively use these communication channels, adapt their messages accordingly to the channels and target groups, and provide reliable information where students actually seek for information.

In particular, against the background of the ongoing corona pandemic, these aspects are of central importance. We can see that in the acute pandemic situation, students' health-related information-seeking behavior shifted significantly. First, the intensity of information seeking increased markedly, while the number of information sources used decreased significantly. Second, students' focus was much more on original journalistic news sources, interpersonal sources, and social media. The reduced diversity of information sources and the comparatively lower importance of search engines could indicate that content from known (and maybe trusted) sources were used in a much more targeted manner. Nevertheless, interpersonal contacts and the great importance of social media and video platforms like YouTube bear the danger of fake news and misinformation that can be especially dangerous in a pandemic situation. At the same time, our data show that a comparatively small percentage of students used information from primary sources, such as health organizations or health professionals, during the pandemic.

For health authorities interested in addressing students' health behavior by means of communication, these findings offer both opportunities and challenges. On the one hand, the increased intensity of information seeking shows a general need and openness for information that trusted sources could satisfy and address by reaching out important health messages to the target group. On the other hand, the reduced diversity of students' information sources and the rather low importance of primary sources clearly restricts the choice of communication channels for this aim during a pandemic situation. Health communication professionals must definitely be aware of these conditions and adapt and tailor their actions to them if they want to be heard.

We found significant correlations with very low (almost negligible) to low-effect sizes between the intensity of corona-related information seeking, risk perception, and actual risk behavior in our cross-sectional data, indicating the possible importance of health information seeking as a potential influencing factor on perception and behavior during the pandemic. At the same time, no such constant correlations with risk perception and risk behavior were found for general health information seeking or corona-related information seeking in the significantly smaller subsample, which could indicate (but does not necessarily mean) that the significant interrelations found might be mainly due to sample size. Accordingly, the findings should be interpreted with care. Furthermore, the direction of the observed relationship is unclear, with both directions being plausible and the possibility of variables influencing each other. It seems highly plausible that a perceived higher risk of being infected can result in a perceived higher need for further information on the topic. At the same time, given the high general relevance of health information for risk perception, the presentation of a (higher/lower) risk by certain information sources could lead to a higher/lower risk perception of the recipients. Likewise, the observed (higher/lower) compliance with health recommendations could be either a result of certain types of risk presentation or, for example, just the expression of certain personality traits leading to a certain information-seeking behavior. Although, based on theoretical assumptions and earlier findings, it can be assumed that information-seeking behavior can have consequences for risk perception and risk behavior, further research is definitively needed.

Although we found that information seeking and risk perception during the pandemic are associated, this association seems to be less strong than one might assume. This could indicate that the information that students receive through the various information channels (and here in particular the mass media reporting that is highly relevant as a source of information in the corona crisis) does not necessarily lead to an increased risk awareness among students. This, in turn, could be related to the widespread narrative, which is also quite common in media coverage (but questionable in terms of content), according to which the protective measures are primarily necessary for protecting the elderly and vulnerable groups. This could lead to the (false) perception among students (and other young people) that the risk of infection for themselves is rather unlikely.

In fact, students tended to estimate the risk of infecting themselves with the virus as rather low. Only 12% of the students considered the risk of infection to be rather, very, or absolutely likely. This is interesting because the age distribution of the infections in most countries suggests that although older people have a greater risk of getting seriously ill, the risk of infection seems to be quite independent of age. In fact, especially during the summer months, in Germany, a disproportionately high number of young people were infected with the virus.

Personal health status does not seem to be associated with the intensity of health information seeking, neither before nor during the pandemic. In contrast, the general interest in health and disease—and this relationship—seems to be quite strong. The same applies for health literacy. This could indicate that even students who perceive their own health condition to be poor might not engage in getting further (and maybe highly relevant) information if they are not interested in health and disease in general and have a rather low health literacy. For health authorities that are especially interested in sending relevant health messages to vulnerable groups that suffer from bad health conditions, it could therefore make sense to also engage in broader campaigns to first increase students' general health literacy and general interest in the topic of health and disease.

Given the great relevance of social media, video platforms such as YouTube, and search engines as sources of health information for students in general and in an acute pandemic situation, the characteristics and quality of the concrete content presented by these information sources and used by the students must be given greater attention in future research. Providers of such platforms should be aware that they have a great responsibility. Fake news and misinformation must be monitored and rigorously pursued and prevented by content moderation and quality monitoring. At the same time, it is important to strengthen the media and health literacy of students to empower their competence to judge which sources and information they can rely on and which they cannot.

However, it should not be overlooked that, especially in a concrete pandemic situation, journalistic news sources, regardless of how they are accessed, still seem to be particularly important for young people to obtain reliable health information. Journalistic reporting is thus highly relevant in the corona crisis from a students' perspective, a tendency that has also been observed in the general population. This finding should incentivize journalistic media to maintain and improve the quality of reporting. At the same time, the question arises as to which concrete sources of information students use and how this use differs from other groups of the population. More in-depth investigations would be necessary, particularly qualitative studies.

As a first step in this line of inquiry, our empirical study has limitations that future work may overcome. First, our samples are structurally different from the student population at the university investigated. As participation was voluntary, it is highly likely that health-interested students tended to participate to a much larger degree than students with a generally lower interest in health and disease, suggesting that our data perhaps missed out a target group highly relevant for health prevention and health promotion. Second, for our larger samples, we provided only cross-sectional data on a macro level. Individual trends over time could only be tracked for a comparatively small subsample, which structurally does not fully reflect the composition of the cross-sectional samples. Further research is therefore needed.

Although we provide data for a large (and in many ways typical) German university, our investigation took place only at one university in Germany. Accordingly, the structural composition of our sample differs in some points from the group of students in Germany as a whole, although this applies less to age than to gender composition. Therefore, the generalization of the findings is limited. This is even more true in the international arena, where not only education and university systems but also the type and intensity of measures and restrictions during the pandemic can vary greatly from country to country.

Nevertheless, our study provides important clues on students' health information-seeking behavior before and during a pandemic situation that can help shape future concepts of prevention and health promotion in the university setting. Our general findings on the important role of online media for student health information seeking are largely in line with the findings of similar studies in other countries. Furthermore, it could be at least assumed that if the tendencies previously stated showed for highly educated and health-interested students, it could be likely to be even more so for less health-interested students and young people from other educational backgrounds. With regard to the specific situation in the pandemic, at this time, there is not enough reliable data available to determine to what extent the present findings are similar or different to developments in other countries. Comparative studies would be very interesting here.

Besides the necessary efforts to increase students' general health literacy, health-related media literacy, including education about the quality of certain information sources, is a central aspect that has to be addressed in the future. This includes workshop concepts to improve students' health-related search (engine) literacy as well as their assessment of the credibility of news and health information sources. Both aspects should be implemented in the context of student health management and could be implemented in school and university teaching.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because of an ongoing project. If required, data can be provided after the end of the project. Requests to access the datasets should be directed to Pavel Dietz, pdietz@uni-mainz.de.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical committees of the Medical Association of Rhineland-Palatinate (No. 2019-14336) and the Institute of Psychology of Johannes Gutenberg University Mainz (No. 2020-JGU-psychEK-S008). 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.

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Pick the Freshmen Up for a "Healthy Study Start" Evaluation of a Health Promoting Onboarding Program for First Year Students at the Carinthia University of Applied Sciences, Austria

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Introduction: Universities are an essential setting for creating health promoting environments. Evidence shows that university life can pose various threats to the students' health. Especially first year students are vulnerable to mental health issues. To support well-being and prevent psychological distress from the first day of studying, onboarding programs are needed to promote the students' health and their self- and social competencies. The study demonstrates a tailored multi-component onboarding intervention program named "Healthy Study Start." An evaluation of the effectiveness is presented focusing on outcomes regarding the students' sense of coherence (S-SoC), social support, sympathy, the work-related collective and the participative safety (a sub-scale of the team climate) among freshmen at the Carinthia University of Applied Sciences (CUAS, Austria).

Methods: For the analyses, a quantitative controlled study design was used and results were measured three times. The intervention group ($n = 72$) was composed of freshmen selected from the bachelor study programs Occupational Therapy, Speech and Language Therapy, Biomedical Science and Radiologic Technology. Freshmen from the bachelor study program Healthcare and Nursing formed the control group ($n = 81$). As the requirements for analyses of variance were not fulfilled, the data had to be analyzed using e.g., Mann-Whitney U-tests.

Results: Significant changes (all $p < 0.016$) between the two groups were found between T0/T1, and between T0/T2. Furthermore, changes within the intervention group (all $p < 0.016$) emerged in nearly all outcomes between T0/T1, while within the control group no changes were identified. However, the intervention group had statistically significantly higher values in the majority of outcomes at T1 and T2 compared to the control group.

Conclusion: The onboarding program "Healthy Study Start" shows how an initiative at the beginning of their studies can support students in entering a new phase of their lives. The results indicate a positive effect on the students' self- and social competencies. However, students' health promotion is not only an investment for a health conscious university or an enhanced employability. Especially in health-related fields of study, students are future multipliers and play an essential role in implementing health promotion concepts for clients, patients and employees.

Keywords: students' health promotion, Healthy Universities, employability, outdoor pedagogical intervention, peer to peer approach, sense of coherence, social belonging, self- and social competencies

INTRODUCTION

In 1995, the World Health Organization (WHO) and the University of Central Lancashire identified universities as an essential setting for creating health promoting environments (1). Since then, the setting has established itself as a health promoting living environment. Exactly 20 years later, in 2015, the latest Charter, the Okanagan Charter (2) called for creating a supportive living environment specifically for the university to promote the health and well-being of students and to support self-competencies. On the one hand, universities are places where students undergo substantial life changes, where opportunities to explore and experiment are offered and the possibility to develop independence and life skills is being given. On the other hand, universities can be seen as a place where students face particular health challenges (3). Indeed, evidence shows an increasing prevalence in mental health issues (4, 5); 12–50% of students meet the criteria for at least one common mental disorder (6). In Austria, 57% of all university students complain to be affected by stress-related challenges, and 48% of the students suffer from mental health issues (7). Grützmacher et al. (8) present nationwide, meaningful and reliable data on students' health situation in Germany. According to their data, 15.6% of the surveyed students show symptoms of a depressive syndrome including loss of joy, interest and energy, and 17.4% suffer from an anxiety disorder. More than a quarter of the surveyed students feel a high level of stress. Exhaustion is experienced by 24.4% of the participants. Furthermore, 22.9% report a sense of loss of importance regarding their studies. Hofmann et al. (9) point out that student-specific burdens include failing exams, coping with university demands, experiencing loneliness, and difficulties in dealing with stress.

Especially the transition from school to university and the associated transition from adolescence to adulthood represent a critical and vulnerable period for young adults. This age span between 18 and 25 years is called "emerging adulthood" (10). Students are in a moral dilemma. On the one hand, starting their university education provides the perfect context for the development of autonomy and the opportunity to establish profound relationships with peers (11, 12). On the other hand, the initial year can be a very stressful experience for students due to new, unprecedented challenges (13). Many factors affect first year students' well-being: change of residence, finding orientation in the new university setting, making new friends, a higher workload or the feeling of competition (9, 11, 12, 14). According to Bruffaerts et al. (6) nearly one third of first year students develop mental health problems during the first 12 months. These problems are associated with lower academic performance. The Austrian Student Social Survey (15) reveals that almost one fifth of first year students suffer from stress-related health issues and 17% from a lack of self-esteem. Besides, 17% report that they find it challenging to organize their studies individually, and 15% complain about depressive moods. Moreover, 14% of the students suffer from existential fears, and 14% are affected by contact difficulties or social isolation.

Evidence points to the fact that most of the psychological distress emerges in the initial year and usually persists throughout the studies' whole duration (16). Students struggle with insufficient time- and self-management, academic demands, lack of confidence, low coping strategies or insufficient capacity to respond to stressful situations (17). To be able to deal with challenging demands, such as the change of residence, orientation within the new university setting, development of new relationships, self-organization, self-efficacy, well-developed social and self-competencies are needed. Strengthened social competencies consolidate the students' ability to form and maintain social relationships and to cooperate with others (18–20). Evidence shows that social support among peers and university friendship groups are the most effective tools for preventing university students' distress (21). Furthermore, social belonging, the feeling of having positive relationships with others, is an individual need (22) which is essential to cope with perceived threats and is related to academic progress, achievement and social acceptance (23). Self-competencies include, for example, self-efficacy, self-management, self-regulation, self-dependence, or stress handling (18–20). To promote those, a strong sense of coherence (SoC) might be useful. From researching a representative sample of the Danish population, Trap et al. (24) have concluded that there is a positive correlation between SoC and self-efficacy. Within the university context, studies show that a higher SoC is related to a better adoption of self-regulated learning strategies, and that students with a higher SoC are more self-regulated in their learning approach (25). Furthermore, better academic performance and social support are associated with a high SoC (26). With a strong SoC, situations are perceived as understandable, meaningful

and manageable, and a recovery from stressful experiences is more efficient (27). In order to strengthen the students' sense of coherence (S-SoC), and thus an important resource for health, it is important that university processes can be understood (comprehensibility), that students see their studies as meaningful (meaningfulness), and that they are able to cope with demands (manageability) (28).

Numerous intervention studies have been carried out and published on how to best promote the students' health and well-being and to reduce stressors and maladaptive coping strategies. They focus on specific risk behavior such as alcohol consumption, drug abuse, sexual health issues, smoking, and sleep problems or media consumption (29, 30). There are also resource-oriented interventions to foster resilience in healthcare students, as shown in the review by Kunzler et al. (31), which provide evidence how a resilience training can improve well-being or stabilize mental health. The authors point to the need for further research. Another systematic review issued by Cooley et al. (32) investigated the use of outdoor adventure education in order to facilitate group work in higher education. Studies included in this systematic review mention short icebreakers (e.g., crossing an imaginary minefield, leading students through a "spider's web") and more challenging activities such as rope courses, rock climbing, caving, trekking and/or orienteering. The outdoor adventure education program was offered to students of different study areas and the majority of the studies were embedded in the degree courses and open for all students. Cooley et al. (32) indicated that these different outdoor education activities might have a positive effect on transferable group skills, because students retained their acquired group work skills when they started higher education. The reviewed studies also indicated a positive effect on team building and some evidence lead to a more positive group environment and more effective group processes. The students' attitudes (e.g., feeling more confident, seeing benefits) toward group work showed a positive development. Lastly, there was evidence that the feeling of social support and integration within the peer group increased.

Resource-oriented approaches for first year students, such as mindfulness training or peer tutoring (16), influence the students' perception concerning their self-care improvement, suggest a reduction of stress related to exams, thus improving scores. de Clercq et al. (33) assessed the effect of two brief social-psychological interventions to promote social-belonging conditions and self-affirmation. The authors describe how the social-belonging intervention has significant effects on outcomes such as social expectations, integration and social studying. However, regarding the intervention concerning self-affirmation only a short-term effect is mentioned.

To sum up, many highly effective intervention approaches exist to promote well-being and health as well as to prevent university students from being exposed to psychological distress. However, a student-tailored health promoting onboarding intervention program, covering social and self-competencies, using different approaches such as outdoor educational, peer to peer and mentoring ones, is still missing. A systematic umbrella review (30) points out a gap in studies concerning health promoting interventions among university students in European countries. The majority of review articles have been published in the US, China and the UK.

Barnett et al. (34) reviewed literature examining the efficacy of psychological interventions (e.g., relaxation, social skills training, attention training, social support, mindfulness, and mediation) regarding the prevention and treatment of mental health disorders in university students. They found out that only 13 out of 84 studies were adapted explicitly for students. Thus, they stress the importance of optimizing interventions for the student population. In terms of a quality development practice of health promotion programs, German speaking countries still lack a sufficient number of published evaluated health promotion interventions to convey substantial information about their benefits and effectiveness (35). Moreover, Cooley et al. (32) indicate that valid questionnaires, strong study designs, analytical procedures and long-term behavior changes are missing.

Summarizing it can be said that in order to enable the students to meet the study-related demands, and to support the students' well-being and prevent them from suffering from possible psychological distress, onboarding programs are needed. It is necessary to promote the students' health and strengthen their self- and social competencies from the first day of studying and consequently over the whole study period and beyond. The present study provides a significant insight into how a student-tailored multi-component onboarding intervention program for first year university students can be composed and contribute to improve the students' health. Additionally, this study procures an important analysis of the effectiveness of the German-speaking regions' onboarding programs.

The development of the onboarding intervention program was based on a mixed methods needs analysis: (1) student-specific burdens and resources, the students' health status, health behavior and interest in health promotion were obtained via a quantitative questionnaire ($n = 31$); (2) resources and strains specific for the study start were investigated within a 4 h "Open Space" session (36). Seventeen students were encouraged within this workshop to develop ideas, based on their personal experiences, about how newly arrived students could be supported by an onboarding intervention program. The results of the quantitative survey and the qualitative "Open Space" session were merged and combined with existing intervention approaches. Based on this procedure, a multi-component onboarding intervention program called "Healthy Study Start" was launched in 2013 to support first year students at the Carinthia University of Applied Sciences [CUAS; (37, 38)] with the aim to promote self- and social competencies of first year students. Since 2015, the program has been an integral part of the curriculum for several health-related study programs. From the moment of implementing the program in 2013, it has continuously been adapted based on the students' feedback. In 2018, a fundamental change of the intervention program was made, due to a relocation. The new location offers attractive indoor and outdoor spaces and the possibility to stay overnight. This environment provides the opportunity to carry out the majority of the program items without a change of location and is ideal for an informal evening program. Particularly the outdoor pedagogical program benefits from the more diverse

environment: the original version was mainly based on exercising on high and low ropes courses, whereas the current version offers a wider range of different tasks, spaces and materials used. To examine the effectiveness of the final version of the program, a broad evaluation of the project was launched in 2019.

The objective of the study was to explore the effectiveness of the onboarding intervention program "Healthy Study Start" for first year students of the CUAS concerning the following outcomes:

a. students' sense of coherence (S-SoC),
b. social support,
c. sympathy,
d. work-related collective efficacy and
e. participative safety (a sub-scale of the team climate).

MATERIALS AND METHODS

The onboarding program was evaluated by using a controlled study design. The "Healthy Study Start" project and the accompanying evaluation were carried out in the department of Health Sciences and Social Work at the CUAS between September 23, 2019 and November 30, 2019.

Study Sample

The intervention program "Healthy Study Start" for freshmen is already an integral part of the curriculum in the bachelor study programs Occupational Therapy, Speech and Language Therapy, Biomedical Science and Radiologic Technology. Thus, the first year students there composed the intervention group (IG, $n = 72$). The onboarding program was implemented for each student class of the four participating study programs. Therefore, the intervention was carried out four times. First-year students attending the bachelor study program Healthcare and Nursing formed the control group (CG; $N = 81$). This study program was best suited as a control group since it also belongs to the health and social studies sector, and an almost comparable number of participants could be collected there. Male and female first year students, from 18 years on, were eligible. Furthermore, the "Healthy Study Start" program and the evaluation are designed to be equally suitable and feasible for students with physical disabilities.

Contents of the Onboarding Program "Healthy Study Start"

The onboarding program is scheduled for 3 days, includes six components and takes place in the first study week. The program combines different didactical approaches (e.g., peer-mentoring, outdoor pedagogical training) and is based on team teaching. Both lecturers are health scientists with longstanding experiences in practice, research and teaching in the field of health promotion, one additionally with a psychological background and the other with an outdoor pedagogical background.

On the first day, the intervention starts with a 1 h information event presided by the director of the study program in order to give the students a first orientation in their new learning environment (module 1) and aims at promoting the student's comprehensibility. Following this, students participate in a quiz about facts on student's health and are introduced to the background, history and procedure of the 'Healthy Study Start' program (module 2). This 90 min long learning session should enable the students to critically deal with students' health related topics, especially focusing on self- and social competencies, which are important skills for their studies, but also for the future employability (39). The aim of module 2 is to enhance the students' awareness for health related topics (e.g., the importance of social support, good self- and time management, coping strategies) and to demonstrate the importance of self- and social competencies for their future working life. The first day ends with 90 min of peer mentoring, developed and conducted by two second-year students of the respective study programs (module 3). Related literature suggests that peer mentoring helps reduce negative effects of stress, provides an access to information about resources at the university, assists with developing skills and promotes social integration (40). It is equally effective in supporting first year students in the transition to university and promotes self- and social competencies (41), which are the aims associated with this third component. The second day takes the students far away from the university campus, to a location in the middle of the woods, where the outdoor pedagogical team training is conducted (module 4). Outdoor based team trainings have been suggested to be feasible and effective in supporting students in developing social competencies and giving students the opportunity to build relationships in an environment away from the daily university routine (42, 43). Some pioneer studies have specifically investigated the implementation of outdoor based team building interventions for first year students. The results indicate that these interventions promote the commitment to the university, facilitate the transition to university life, help newcomers to build positive and trustful relationships with peers and improve their communication and time management skills (44–46). This all-day event starts with a 5 min icebreaker activity and includes five team challenges in the morning, lasting between 30 and 45 min each. In the afternoon, the students have to master a 2 h construction project, go on a hiking tour and finally the program ends with a sound meditation to cool down. The different challenges offer students the opportunity for a collaborative, experiential learning in the following fields: strategizing, planning, decision-making, time management, targeted communication, trust in peers, dealing with frustration and mutual motivation. The acquired group work skills should facilitate a work-related collective efficacy from the beginning of their studies. Module 4 aims to enhance social support, sympathy and participative safety within the group by means of experiencing an intensive cooperation and becoming more familiar with peers. The description of the tasks is outlined in **Table 1**.

Before the informal evening program starts, module 5 takes place in a relaxed atmosphere: "Meet the Lecturer" provides information about the new living and learning environment, e.g., structure, mission, as well as the people important to know and their roles in the university setting. This component offers some informal tips and tricks from the perspective of an

TABLE 1 | Task description "Healthy Study Start."

Challenge	Description	Time
Stepping stones	The team has to overcome a distance of 30 m without touching the ground by using stepping stones. At the same time, they have to fulfill additional tasks such as moving around blindfolded or changing places with other team members. The amount of stepping stones corresponds to the number of participants. For each rule violation (touching the ground) the team loses one stepping stone	30 min
Rope figures	The team members have to spread evenly along a 30-m rope; everybody should hold the rope in their right hand and form a circle together. The game master shows different polygons, (e.g., pentagram) and the team has to copy the figures by moving their bodies but without changing the position of their hand on the rope	30 min
Spider's web	Between two trees, a rope is tensioned zigzag to build a two meters high and two meters wide spider's web with eight openings. All team members stand on the same side of the web and have to pass the spider's web in order to get to the other side. This has to be done by using the openings equally frequently and without touching the web. In case of a rule violation (touching the spider's web), all team members have to go back to the starting point	30 min
Wooden board	The team has to move a wooden stick (three meters long) through five round openings (different diameters) in a wooden board by commonly balancing it on small sticks. It is not allowed to touch the board neither with the long nor with the small sticks. In case of a rule violation, the team has to start again	30 min
Silent sign	The team has to split into two groups, which are positioned at a distance of 25 m. Both groups get one part of a literary quote about studying. The goal is to recombine the two parts of the quote without talking, only by communicating with body movements based on a coding table with the alphabet and its translation into body positions. At the end of the challenge, both groups should have written down the whole literary quote	45 min
Wooden dome	The team has to form two groups, and each receives 150 wooden sticks in three different lengths and connecting pieces with four, five and six openings. The students have to build two wooden, stable domes, three meters high and wide, and they have to use the entire material. During the activity, the two teams are shown different parts of the construction plan for a few seconds and have to exchange the information received to achieve the given goal	120 min
Hiking and talking	During a hiking tour in the woods, the students receive little notes with questions concerning their private life (e.g., hobbies) and about study related topics (e.g., motives for study choice) as conversation starters. They are encouraged to talk in pairs and change the conversation partners several times	120 min

experienced professor. The session aims at making university life more understandable and manageable for students. The second day ends with joint cooking, a campfire and an overnight stay in the location. Finally, the last component, module 6, of the 'Healthy Study Start' program happens after breakfast on the third day. During a 90 min long transfer session, students should reflect on the experiences they have made during the outdoor pedagogical training and work on a case study on successful teamwork. Finally, they have to define and sign their ten rules of team working for their 3 years of studies to come. Module 6 aims to promote and strengthen the above mentioned aims of module 4, in order to introduce them into the university setting.

The usual welcome day program of the CUAS, including the ICT (Information and Communication Technology) training, the explaining of the building services and the introduction to the library, is generally offered to freshmen of the intervention and the control group.

For the control group the information period ends here with greetings from the heads of the study area and the study program and a film about nursing. Last time, immediately afterward, one group already started their courses with the first units about "medical terminology" and the other group went home.

Data Collection

A quantitative test battery was performed at three different times: on the first day of studying (=baseline, T0), at the same time for the intervention and the control group, then directly after the end of the intervention program "Healthy Study Start" (T1) for the intervention group and at the end of the first week for the control group, plus a follow up 2 months later (T2).

Students are informed about the study's aims and data security and that participation is voluntary. Everyone has the right, without giving reasons, to refuse participation. Although the intervention program "Healthy Study Start" is anchored in the intervention group's curriculum and ECTS credits are provided, there is no obligation to participate. ECTS credits can also be achieved in form of substitute performances.

Outcomes and Measurements

For the analysis of the program's effectiveness the students' sense of coherence (S-SoC), social support, sympathy, work-related collective efficacy and the participatory safety were defined as outcomes. As sociodemographic variables, sex and age were collected.

Students' Sense of Coherence (S-SoC). The 12-item reliable and valid S-SoC scale and its sus-scales comprehensibility (4 items, e.g., *"For me, the Carinthia University of Applied Sciences has clear and transparent structures."*), meaningfulness (5 items, e.g., *"I have the feeling that the Carinthia University of Applied Sciences is an enrichment for my life."*) and manageability (3 items, e.g., *"Whenever I am faced with a difficult problem at the Carinthia University of Applied Sciences, I find people who help to solve my problem."*) were used. According to Brunner et al. (28) Cronbach's alpha is 0.73; for this sample Cronbach's alpha at T0 was 0.80. The S-SoC scale is setting-specific and the items are adapted to the CUAS setting (e.g., "*The CUAS* has clear and transparent structures for me."). The items could be answered on

a seven-point rating scale ranging from 1 = "does not apply at all" to 7 = "applies fully." Three items had to be reversed before the calculation. For further calculations, the total score, as well as the mean values per sub-scale, could be determined. Higher values indicate a stronger S-SoC.

Social Support

The sub-scale of the German questionnaire "Ressourcen und Belastungen von Studierenden" [Resources and demands in Higher Education" (47)] for students was used, ensuring a setting-specific measure. For this sample, Cronbach's alpha at T0 was 0.87. The four items (e.g., *"I easily find someone who informs me or brings me working materials if I cannot come to the university."*) could be answered on a six-point rating scale: "never," "rarely," "sometimes," "frequently," "very frequently," and "always" were offered. High values indicate a high level of perceived social support.

Sympathy

The perceived sympathy among the students was measured as an indicator of group sensitivity. Therefore, items of the "Gruppenbefindlichkeitsfragebogen" [Group sensitivity questionnaire (48)] were used. Some items were adapted to the university context [e.g., "I like most of them *(fellow* students) a lot."]. For this sample, Cronbach's alpha at T0 was 0.85. The items could be answered on a five-point rating scale from 5 = "strongly agree" to 1 = "strongly disagree." An overall score can be calculated for all items, 4–9 points meaning low sympathy, 10–15 points moderate sympathy, and 16–20 points high sympathy.

Work-Related Collective Efficacy

The valid scale (Cronbach's alpha = 0.76, for this sample Cronbach's alpha at T0 = 0.84) is specifically designed for work-related teamwork settings and consists of 8 items (49). All items were adapted to the university context (e.g., "I have confidence that together, *as a student group*, we can manage to meet the project/*university requirements* even under difficult conditions."). All positively formulated items could be answered on a four-point rating scale (4 = "strongly disagree," 3 = "rather disagree," 2 = "partly agree," and 1 = "strongly agree"). Low values indicate a high level of work-related collective efficacy.

Participative Safety

The reliable (Cronbach's alpha = 0.89, for this sample Cronbach's alpha at T0 = 0.87) participative safety scale is a sub-scale of The Team Climate Inventory (50). It combines the following sub-scales: information sharing (Cronbach's alpha = 0.72; 3 items), safety (Cronbach's alpha = 0.65; 2 items), influence (Cronbach's alpha = 0.61; 3 items) and interaction frequency (Cronbach's alpha = 0.79; 4 items). Some items were adapted to the university context [e.g., "Team members *(members of the student group)* feel accepted and understood by the others."]. The items could be answered on a five-point rating scale from "1 = strongly disagree" to "5 = strongly agree," respectively "1 = to a very little extent" to "5 = to a very great extent." For each sub-scale and the overall scale, a score could be calculated on an individual level. High values mean a high level of participative security.

Statistical Analyses

The employed measures (S-SoC, social support, sympathy, work-related collective efficacy and participative safety) are scales consisting of ordinal items, which are averaged to form scores. At all three measurement time points (at the baseline, immediately after the intervention, and 2 months later), questionnaires were handed out to the participants in both groups, leading to a longitudinal design. Unfortunately, assumptions required for linear methods (e.g., repeated-measures ANOVA) like normality or variables on an interval scale do not hold. Therefore, the data had to be analyzed using a different methodology.

Non-parametric methods (e.g., Mann-Whitney U-tests) can be used to answer cross-sectional questions (e.g., group differences at a specific time point). Due to this study's longitudinal design and scope, the authors opted to calculate differences between time points and to analyze them using nonparametric tests. Differences between time-points (0, 1, 2) are denoted as Δ_{01}, $\Delta_{12,}$ and Δ_{02} for the changes between time-points 0 and 1, 1 and 2, as well as 0 and 2. They are calculated by subtracting the *earlier* from the *later* measurement results, for example, manageability Δ_{02} = manageability$_2$–manageability$_0$, which yields the following intuitive interpretation: Positive differences signify that manageability$_2$ > manageability$_0$, therefore manageability-values have increased while negative differences mean that the values have decreased over time.

If either of the two variables contains a missing value, the difference becomes classified as missing. Therefore, differences between medians of variables at specific time-points (cross-sectional; e.g., manageability at t_0 and t_1) can differ slightly from the medians of the aforementioned differences (longitudinal; e.g., manageability Δ_{01}).

Thus, it can be assessed whether there are changes within a group between time points (testing whether the median differs significantly from 0 for one group) and whether the changes over time are different between groups (test differences between groups).

Since this study aims to assess the effectiveness of the intervention and there are neither prior knowledge nor empirically substantiated assumptions about the effects, all tests are two-sided. Furthermore, although an improvement of students' experiences at the university is at the heart of such interventions, the authors could not rule out unanticipated adverse effects, which would have gone unnoticed in one-tailed tests.

To account for multiple testing, the $\alpha = 5\%$ was adjusted using a Bonferroni-correction (adjusted $\alpha = 0.016$). Effect sizes (η^2) were computed are considered small for $\eta^2 < 0.060$, medium for $0.060 \leq \eta^2 < 0.140$, and large for $\eta^2 \geq 0.140$ (51).

RESULTS

Descriptive Results

A total of 153 freshmen participated in this study, the intervention group including 72 students and the control group 81 students. No dropouts between the occasions were noticed. The majority were women ($n = 141$; missing = 1) and the average age was 22.17 years ($SD = 5.540$).

On the first day of studying (T0), with the exception of social support, no statistically significant differences between both groups were found. After the intervention (T1), the intervention group found university life significantly more manageable than the control group. No significant differences were identified between the two groups immediately after the intervention regarding the sub-scales meaningfulness, comprehensibility and social support. However, 2 months later (T2) the intervention group had a statistically significant (all $p < 0.005$) higher feeling of comprehensibility and social support than the control group. After the intervention, the intervention group felt a significantly higher sympathy toward each other than the control group.

Furthermore, the intervention group had a statistically significantly higher sense of safety and influence than the control group. Additionally, the interaction frequency and the feeling of participative safety were significantly higher within the intervention group after the intervention. Two months later (T2) the intervention group had a statistically significantly (all $p < 0.005$) better feeling of manageability, sympathy, work-related collective efficacy, participatory safety, and information sharing, safety, influence and interaction frequency (**Table 2**).

Changes in S-SoC, Social Support, Sympathy, Work-Related Efficacy and Participative Safety Within the Intervention Group and the Control Group

A statistically significant change within the intervention group was found in all outcomes, excepted meaningfulness, between the baseline (T0) and after the intervention (T1). Within the control group, no statistically significant changes emerged (Δ_{01}). Overall, the values for manageability and meaningfulness remained constant for the intervention group while they significantly decreased within the control group from T0 to T2 (Δ_{02}). While the intervention group started with a significant decline in the S-SoC sub-scale manageability from the baseline to after the intervention, there was no statistically significant change between T1 and T2 (Δ_{12}). The control group, however, did not show a significant change after the baseline (T0), but had a substantial drop between T1 and T2 and throughout the study (Δ_{02}). While social support remained constant for the control group, it statistically significantly increased within the intervention group after the intervention (T1). Furthermore, there was a convincing increase within the intervention group over the duration of the study. The sympathy toward each other increased statistically significantly more within the intervention group than in the control group over the duration of the study (Δ_{02}). The level of the work-related collective efficacy remained constant for the control group from T0 to T1 while it substantially increased within the intervention group from T0 to T1 and across all measurement points (Δ_{02}). While the values within the sub-scale information sharing remained constant for the control group, the values for the intervention group increased statistically significantly between T0 and T1. Over time, from T0 to T2, the values within the sub-scale information sharing increased substantially within the intervention group and the control group. No statistically relevant changes were found for the control group for the sub-scales safety, influence, interaction frequency, and overall scale participative safety across all measurement points (Δ_{02}). Whereas, for the intervention group significantly increases within the sub-scales safety, influence, interaction frequency and the overall scale participative safety from T0 to T2 were identified (**Table 3**).

Changes Between Intervention and Control Group in S-SoC, Social Support, Sympathy, Work-Related Efficacy and Participative Safety Over Time

Table 4 shows significant changes and effect sizes between the intervention and the control group between the measurement points. The Mann-Whitney U-tests elaborated substantial changes (all $p < 0.016$) between the groups from T0 to T1 in sympathy, the participatory safety and the sub-scale interaction frequency with strong effect sizes and medium effect sizes for social support, work-related collective efficacy, the sub-scales information sharing, safety and influence. Small effect sizes were found for manageability and comprehensibility, whereas no significant changes emerged within the sub-scale meaningfulness. Across all measurement points, from T0 to T2, statistical changes between the intervention and the control group with strong effect size were registered in the sub-scale influence and medium effect sizes in manageability, comprehensibility, social support, sympathy, the overall scale participatory safety and the sub-scales safety, influence and interaction frequency. Regarding meaningfulness, only a small effect size between the changes was detected.

DISCUSSION

The onboarding program "Healthy Study Start" shows how an initiative at the beginning of their studies can help students manage this new phase of their lives. It features a clear and conceptual framework and follows a "key principle" of health promotion defined by the WHO (52): the target group's participation. The "Healthy Study Start" intervention program engages students to participate in its development actively. So modules, tailored to the needs of the target group, were conceptualized and students' resources are used and the intervention program's acceptance can be increased by involving the individuals concerned (53). The different didactical approaches (e.g., peer to peer approach, outdoor pedagogical approach) enable students to engage in self-directed, active and interactive learning processes to support self- and social competencies, which promote their self- and professional development (54). Another strength of this onboarding program is the team-teaching approach, with two health promotion experts, one in outdoor educational training and the other in psychology supervising the "Healthy Study Start." To the best of the authors' knowledge, this is the first controlled study to evaluate a health promoting onboarding program for first year students concerning self- and social competencies, especially S-SoC, social support, sympathy, work-related collective efficacy and the participative safety. Statistically significant differences

TABLE 2 | Participants' medians on the outcomes and group differences at all three measure points.

	Baseline (T0)			After Intervention (T1)			Two months later (T2)		
	IG Median (IQR)	CG Median (IQR)	*p*	IG Median (IQR)	CG Median (IQR)	*p*	IG Median (IQR)	CG Median (IQR)	*p*
S-SoC									
Manageability	5.33 (4.33–5.67)	5.00 (4.67–5.67)	0.473	5.33 (4.92–6.00)	5.00 (4.33–5.67)	**0.021**	5.00 (4.33–5.92)	4.33 (3.67–5.33)	**0.001**
Meaningfulness	5.20 (4.60–5.60)	5.40 (4.60–5.80)	0.126	5.20 (4.60–5.60)	5.20 (4.25–5.80)	0.804	5.00 (4.45–5.80)	4.80 (4.00–5.40)	0.057
Comprehensibility	5.00 (4.50–5.75)	5.00 (4.50–5.50)	0.457	4.50 (4.00–5.525)	4.75 (4.25–5.50)	0.216	4.75 (3.75–5.25)	4.00 (3.00–4.75)	**<0.001**
Social support	3.50 (2.50–4.44)	3.75 (3.00–4.81)	**0.018**	4.00 (3.25–4.50)	3.75 (3.25–4.63)	0.480	4.75 (4.25–5.25)	4.25 (3.50–5.00)	**0.002**
Sympathy	14.00 (12.00–16.00)	13.00 (12.00–16.00)	0.566	17.50 (16.00–19.00)	14.00 (12.50–16.00)	**<0.001**	18.00 (16.00–19.75)	16.00 (13.00–17.00)	**<0.001**
Work–related collective efficacy*	1.83 (1.50–2.00)	2.00 (1.50–2.17)	0.236	1.50 (1.17–1.83)	2.00 (1.50–2.00)	**<0.001**	1.67 (1.167–2.00)	2.00 (1.67–2.17)	**0.003**
Participative safety									
Information sharing	11.00 (9.00–12.00)	11.00 (10.00–12.00)	0.368	12.00 (11.00–14.00)	11.00 (9.00–13.00)	**<0.001**	13.00 (12.00–14.00)	12.00 (10.00–14.00)	**<0.001**
Safety	8.00 (7.00–9.00)	8.00 (7.00–9.00)	0.967	8.50 (8.00–10.00)	8.00 (6.00–9.00)	**<0.001**	9.00 (8.00–10.00)	8.00 (7.00–9.00)	0.050
Influence	11.00 (9.00–12–00)	11.00 (9.00–13.00)	0.268	12.00 (11.00–13.00)	11.00 (9.00–13.00)	**0.005**	14.00 (12.00–15.00)	12.00 (10.00–13.00)	**0.044**
Interaction frequency	13.00 (11.00–16.00)	14.00 (12.00–16.00)	0.128	16.00 (14.00–18.00)	13.00 (12.00–16.00)	**<0.001**	17.00 (15.00–18.00)	15.00 (11.25–16.00)	**<0.001**
Overall P.s.**	43.00 (37.00–48.00)	45.00 (38.50–50.00)	0.189	48.00 (45.00–53.00)	42.50 (36.00–49.75)	**<0.001**	53.50 (48.00–56.25)	47.00 (41.00–52.00)	**<0.001**

Numbers in bold indicate $p < 0.05$.
Data were expressed as median (IQR) at the baseline (T0), after the intervention (T1) and 2 months later (T2) for the intervention group (IG) and the control group (CG).
Mann-Whitney U-test: p-Values for group differences.
**Low values indicate a high level of work-related collective efficacy.*
***For the Participative safety scale an overall score was calculated (Overall P.s.).*

between the intervention and the control group and statistically significant changes within the intervention group indicate positive effects on the students' self- and social competencies. Statistically significant changes (all $p < 0.016$) between the intervention group and the control group from T0 to T1 were found in manageability, comprehensibility, social support, sympathy, work-related collective efficacy, the participatory safety scale and all sub-scales with medium to large effect sizes. Over time, from T0 to T2 statistically changes between the intervention and the control group were identified in the sub-scale influence with strong effect size and medium effect sizes in manageability, comprehensibility, social support, sympathy, the overall scale participatory safety and the sub-scales safety, influence and interaction frequency. Compared to the control group the intervention group showed significant positive changes within all outcomes, with the exception of meaningfulness (no change was found) and comprehensibility, whose numbers decreased between T0 to T1. An explanation for no statistical changes regarding meaningfulness can be found in the students' study motives. It can be assumed that students choose their line of studies based on their huge desire to engage in a "meaningful profession" and so, due to the limited number of university places, they have to deal with this issue intensively during the admission procedure (55, 56). Another reason could be that the "Healthy Study Start" program promotes the overall S-SoC, whereas there is no tailored intervention to promote meaningfulness. Over time, within the intervention group, positive changes in social support, sympathy, the overall scale participatory safety and the sub-scales occurred. However, in a cross-sectional comparison at the follow up, the intervention group showed statistically significant higher values in nearly all outcomes. These results suggest that the intervention program had a positive effect on the S-SoC scales manageability and comprehensibility. This might especially be connected to the 1 h information event with the director of the study program, the "Meet the Lecturer" event and the reflection and transfer session, because these offers combined may lead to a more detailed discussion about university structures and processes and an intensive confrontation with comprehensibility and manageability within the university setting. It is widely accepted that a strong SoC is a psychological resource that strengthens the individual's competence to deal with environmental strains

TABLE 3 | Changes in S-SoC, social support, sympathy, work-related collective efficacy, and participative safety within the intervention group and the control group.

	Median difference between T0 and T1 (Δ_{01})				Median difference between T1 and T2 (Δ_{12})				Median difference between T0 and T2 (Δ_{02})			
	IG		CG		IG		CG		IG		CG	
	Δ_{01}	*p*	Δ_{01}	*p*	Δ_{12}	*p*	Δ_{12}	*p*	Δ_{02}	*p*	Δ_{02}	*p*
S-SoC												
Manageability	0.33	**0.012**	−0.33	0.087	−0.33	0.020	−0.33	**0.002**	0.00	0.862	−0,67	**<0.001**
Meaningfulness	0.20	0.165	−0.20	0.127	0.00	0.559	−0.20	**0.003**	0.10	0.982	−0.40	**<0.001**
Comprehensibility	−0.50	**<0.001**	0.25	0.501	0.00	0.311	−1.00	**<0.001**	−0.50	**0.001**	−1.25	**<0.001**
Social support	0.50	**<0.001**	0.00	0.946	0.75	<0.001	0.50	**<0.001**	1.25	**<0.001**	0.25	**0.008**
Sympathy	4.00	**<0.001**	0.00	0.067	0.00	0.581	1.00	0.083	3.00	**<0.001**	1.00	**0.005**
Work-related collective efficacy*	−0.33	**<0.001**	0.00	0.946	0.00	**0.016**	0.00	0.196	0.00	**0.009**	0.00	0.448
Participative safety												
Information sharing	1.50	**<0.001**	0.00	0.845	1.00	0.101	1.00	**0.001**	2.00	**<0.001**	1.00	**0.002**
Safety	1.00	**<0.001**	0.00	0.305	0.00	0.971	1.00	0.051	0.50	**0.001**	0.00	0.287
Influence	1.00	**<0.001**	0.00	0.728	1,00	**<0.001**	0.00	0.115	3.00	**<0.001**	0.00	0.434
Interaction frequency	3.00	**<0.001**	0.00	0.093	1.00	0.058	1.00	0.077	3.00	**<0.001**	0.00	0.790
Overall P.s.**	6.50	**<0.001**	0.00	0.380	2.00	**0.002**	2.00	0.021	9.00	**<0.001**	2.00	0.047

Numbers in bold indicate adjusted $p < 0.016$.

The table presents median differences (Δ) between baseline (T0) and after the intervention (T1), after the intervention (T1) and the follow-up (T2) and baseline (T0) and follow-up (T2) for the intervention group (IG) and control group (CG).

Mann-Whitney U-test: p-values for differences within the IG and control group CG from T0 to T1, T1 to T2, and from T0 to T2.

**Neg. values means an increase of work-related collective efficacy.*

***For the Participative safety scale an overall score was calculated (Overall P.s.).*

and stressful situations (57). Evidence shows positive associations between a strong SoC and academic success and achievement (25, 58, 59), social support (25) and adaptive coping behavior (60). Hence, universities should invest in identifying students with low SoC, using a setting-specific measurement such as the S-SoC scale (28) to offer early and timely health promoting interventions. Dooris et al. (61) point out that investigating health and well-being in the university setting should not be done without addressing health needs and problems with a salutogenic focus. Furthermore, the predominantly positive results suggest that the program is a meaningful and interesting method for students to develop social competencies and to promote a trusting climate within the student group. The onboarding program "Healthy Study Start" follows a multifaceted didactical approach including an outdoor pedagogical, a peer to peer and a team-teaching approach. Outdoor pedagogical trainings offer a good opportunity for students to test their ability to cooperate in a setting far away from the university. Furthermore, they enlarge already existing competencies, helping to reflect on weaknesses and to experience the satisfaction of doing things in a group (42). Lastly, they demonstrate that the use of a peer to peer approach provides social connections with other students, which in turn has a positive effect on the sense of belonging, the development of social skills, enhancing the identification with the university context, getting information about resources on campus and academic success (40). Peer to peer support (e.g., peer coaches or peer mentoring) can help to strengthen self-efficacy, support study strategies, improve study habits over time or to overcome study related demands (62). The statistical decrease of the control group's manageability values could be explained by the lack of personal competencies and social support by fellow students to cope with high study-related demands. Bengel et al. (63) report that manageability includes the feeling of having own resources and competencies and the belief that other people can help overcome difficulties. Therefore, manageability improves with social support, which might be essential to cope effectively with stressors. Furthermore, the supervised onboarding program with a team-teaching approach can also positively contribute to the intervention group results. The review of Conely et al. (64) identified that supervised skills training programs were far more effective than others with regard to outcomes including stress, general psychological distress, social or emotional skills, self-perception or academic adjustment.

For the mentioned approaches, positive associations with self- and social competencies have been found in different studies. For instance, Wolfe and Kay (46) state in their study that a first year student's participation in an outdoor orientation program results in a higher commitment to the university, a more successful transition to university life, an emotional, social, and personal growth and positive relationships with others. Bell et al. (65) reviewed 25 published studies examining outdoor orientation programs and conclude that such programs support a sense of belonging among students and healthy peer connections. Furthermore, Herrmann-Werner et al. (66) find that a Tandem Program reduces perceived stress and improves the ability to work in a team within medical students. The systematic review of Akinla et al. (67) analyzed near-peer mentoring programs for first year medical students and identify

TABLE 4 | Changes in S-SoC, social support, sympathy, work-related collective efficacy, and participative safety between the intervention and control group.

	Baseline (T0)		After Intervention (T1)		Two months later (T2)		Changes_TOT1 between IG and CG		Changes_T1T2 between IG and CG		Changes_T0T2 between IG and CG	
	IG Median (IQR)	CG Median (IQR)	IG Median (IQR)	CG Median (IQR)	IG Median (IQR)	CG Median (IQR)	*p*	ES	*p*	ES	*p*	ES
S-SoC												
Manageability	5.33 (4.33–5.67)	5.00 (4.67–5.67)	5.33 (4.92–6.00)	5.00 (4.33–5.67)	5.00 (4.33–5.92)	4.33 (3.67–5.33)	**0.003**	0.059	0.348	0.006	**<0.001**	0.087
Meaningfulness	5.20 (4.60–5.60)	5.40 (4.60–5.80)	5.20 (4.60–5.60)	5.20 (4.25–5.80)	5.00 (4.45–5.80)	4.80 (4.00–5.40)	0.033	0.031	0.086	0.020	**0.005**	0.050
Comprehensibility	5.00 (4.50–5.75)	5.00 (4.50–5.50)	4.50 (4.00–5.525)	4.75 (4.25–5.50)	4.75 (3.75–5.25)	4.00 (3.00–4.75)	**0.013**	0.041	**<0.001**	0.129	**0.001**	0.069
Social support	3.50 (2.50–4.44)	3.75 (3.00–4.81)	4.00 (3.25–4.50)	3.75 (3.25–4.63)	4.75 (4.25–5.25)	4.25 (3.50–5.00)	**0.001**	0.077	0.081	0.020	**<0.001**	0.123
Sympathy	14.00 (12.00–16.00)	13.00 (12.00–16.00)	17.50 (16.00–19.00)	14.00 (12.50–16.00)	18.00 (16.00–19.75)	16.00 (13.00–17.00)	**<0.001**	0.171	0.237	0.009	**<0.001**	0.098
Work-related collective efficacy*	1.83 (1.50–2.00)	2.00 (1.50–2.17)	1.50 (1.17–1.83)	2.00 (1.50–2.00)	1.67 (1.167–2.00)	2.00 (1.67–2.17)	**0.002**	0.064	0.664	0.001	0.30	0.032
Participative safety												
Information sharing	11.00 (9.00–12.00)	11.00 (10.00–12.00)	12.00 (11.00–14.00)	11.00 (9.00–13.00)	13.00 (12.00–14.00)	12.00 (10.00–14.00)	**<0.001**	0.132	0.163	0.013	0.028	0.032
Safety	8.00 (7.00–9.00)	8.00 (7.00–9.00)	8.50 (8.00–10.00)	8.00 (6.00–9.00)	9.00 (8.00–10.00)	8.00 (7.00–9.00)	**<0.001**	0.073	0.028	0.031	0.130	0.015
Influence	11.00 (9.00–12.00)	11.00 (9.00–13.00)	12.00 (11.00–13.00)	11.00 (9.00–13.00)	14.00 (12.00–15.00)	12.00 (10.00–13.00)	**0.001**	0.077	0.040	0.027	**<0.001**	0.157
Interaction frequency	13.00 (11.00–16.00)	14.00 (12.00–16.00)	16.00 (14.00–18.00)	13.00 (12.00–16.00)	17.00 (15.00–18.00)	15.00 (11.25–16.00)	**<0.001**	0.222	0.639	0.001	**<0.001**	0.131
Overall P.s.**	43.00 (37.00–48.00)	45.00 (38.50–50.00)	48.00 (45.00–53.00)	42.50 (36.00–49.75)	53.50 (48.00–56.25)	47.00 (41.00–52.00)	**<0.001**	0.217	0.947	0	**<0.001**	0.131

Numbers in bold indicate adjusted $p < 0.016$.

Data were expressed as median (IQR) for baseline (T0), after the intervention (T1) and the follow-up (T2).

Mann-Whitney U-test: p-value for changes between the intervention group (IG) and the control group (CG) from T0 to T1, T1 to T2, and from T0 to T2.

ES = effect size (η^2): small = 0.010 ≤ to < 0.060, medium = 0.060 ≤ to < 0.140, and large = > 0.140.

**Low values indicate a high level of work-related collective efficacy.*

***For the Participative safety scale an overall score was calculated (Overall P.s.).*

near-peer mentoring as a promising intervention concerning professional and personal development, stress reduction and ease of transition. Within the onboarding program "Healthy Study Start" all successful approaches are used in combination, although it is difficult to conclude which approach is effective and influences which outcome.

Contribution to the Field of Students' Health Promotion

This study suggests that the participation of the target group and the combination of a multifaceted didactical approach targeting self- and social competencies may be a promising strategy to promote health and well-being among university students. Besides, this health promoting onboarding program may lead to more understanding of how health and well-being can be promoted within the setting. The support of a healthy personal and social development, the guarantee of a healthy and sustainable working environment, the encouragement of a wider academic interest and the permanent engagement in health promotion are objectives of a Health Promoting University (68). Through the curricular anchoring of the onboarding program "Healthy Study Start" into some degree programs and the associated commitment to invest in student health, first steps toward the Healthy University approach have been set. In addition, the focus on developing self- and social competencies and the evaluation of the program contribute to Healthy Universities. However, it is not solely in the interest of a healthy university that the promotion of personal and social skills among students is implemented. The focusing on the students' self- and social competencies is also in line with the requirements of employability by the European Higher Education Area (Bologna Process) (69). While the term "employability" was minimized to job-relevant opportunities for graduates some time ago, nowadays this term encompasses the ability to acclimatize in a dynamic and transforming labor market and beyond (70). The Yerevan Communiqué (71) advocates that necessary competencies should be trained during the period of studies in order to qualify for a long-term and successful position in the labor market and beyond. The "Healthy Study Start" program follows these requirements and enables students at the beginning of their studies to reflect on their resources, the study-related demands, and to deepen associated key competencies. Focusing on self- and social competencies (e.g., cooperation and communication, teamwork, self-regulated learning and self-awareness) plays a major role in this context (19). Universities are required to promote them in order to support the students' health and ability to study (72). The need for well-developed self- and social competencies has especially become apparent under the special COVID-19 conditions. Students suffer due to social distancing and lack of social support (73, 74). Changing learning environments, particularly a focus on E-Learning, can lead to difficulties with an effective study organization (73). Especially students from healthcare-related study programs are suffering (75). Therefore, it seems even more important to provide adequate support for these students (76). In order to offer students a healthy study start despite the COVID-19 restrictions, the onboarding program has been adapted and adjusted to the current conditions (e.g., no overnight stay, using a corona hygiene sanitation protocol, using materials that are suitable for disinfection). However, the program was adapted to a unique situation and had no impact on this evaluation; as soon as circumstances change, the evaluated "Healthy Study Start" program will be provided again as per the description. Due to the importance of interventions supporting self- and social competencies and health promotion in general, they should not be limited to the beginning of a study program but rather need to be offered throughout the whole study duration. This commitment can guarantee sustainability in working for the students' health and an improvement for the study situation. For this reason, in March 2019, another project named KukiS-Toolbox (a German project called "Kompetent und kohärent im Studium-Toolbox" was designed to enhance self- and social competencies among students) started at the CUAS. It focuses on strengthening the dimensions of S-SoC, on promoting group support and the sense of belonging by developing learning and teaching materials, targeting full-time and part-time students. The materials are available for students and staff. Further, a "Student Health Advisory Board" will be set up, so students can voice health issues concerning their communities and participate in the design of health promoting processes within the university, in this case within the CUAS. As a supportive living environment promoting a student health management (77), the university has still not sufficiently arrived in the focus of attention in Austria, compared to other German-speaking and international areas. However, intervention programs like the 'Healthy Study Start', the project "KukiS-Toolbox" and the intended "Student Health Advisory Board" send a first signal for an effective students' health management (78) in Austria. Furthermore, it should be noted that health promotion for students is not exclusively an investment in students' health and well-being during their study period. If they develop awareness for health promotion topics during their studies, they can take on a pioneering role in their future working lives; they are considered multipliers for health promotion (79). Especially in health-related fields of study, students, as future multipliers in the healthcare sector, can play a significant role in workplace health promotion for clients, patients and employees (80).

Limitations

We acknowledge some limitations to the study. Due to the sample population, some discovered effects might be attributable to the specific setting (CUAS students). More data would permit a more comprehensive analysis. Bias could occur because the control group consists of nursing students only, compared to the intervention group, which comprises a diverse set of students. Furthermore, a gender bias is possible, because a large proportion of female students from health-related study fields participated in the study. The students' perceptions, which could be influenced by numerous factors at the time of completing the questionnaire, may under- or overestimate the actual knowledge and skills acquired.

Moreover, there could be different co-variables, e.g., the fact that Universities of Applied Sciences provide a kind of family

atmosphere, that a full-time study mode is offered and that these study fields have extensive practical training within their curricula. Since all variables are self-reported, the authors cannot rule out a social desirability bias. Furthermore, an investigation into long-term behavior changes is missing. Despite these limitations, the present study contributes to improve the terms of quality development practices of health promotion programs for the German-speaking countries.

Implications for Future Research

Although the onboarding intervention would be well-applicable to other study areas, the transfer of results and recommendations needs to be considered with caution, as findings might not be generalizable or appropriate for other fields. Therefore, students of different study areas, such as Management, Engineering and IT or Civil Engineering and Architecture should be included in health promoting onboarding intervention programs. Further research should focus on long-term studies with multiple repeated measurements, including outcomes like study success, study retention or study dropout rate.

CONCLUSION

The initial study phase is a central starting point for health promoting interventions in the university setting. In order to address the students' needs, use their resources and increase acceptance, students should participate in the development of health promoting interventions. Fellow students are an important resource, thus it is vital to strengthen the relations in health promotion initiatives from the beginning of the studies. Furthermore, SoC and a salutogenic approach should be considered in intervention planning to promote the students' health, academic achievement and success. Onboarding intervention programs can benefit from alternative didactical approaches. Finally, the evaluation contributes to the development of quality within health promoting interventions and demonstrates the value of health promotion initiatives for students and, consequently, the university. Therefore, arguments for the funding and sustainable implementation of health promotion within the university setting are provided.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the datasets generated for this study will not be made publicly available based on the paragraph in the Informed Consent that exclusively project staff have access to the collected data as well as to the source documents. Requests to access the datasets should be directed to Andrea Limarutti, a.limarutti@fh-kaernten.at.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Medical Ethics Committee of Carinthia, Austria (EK Nr. A35/19). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

In 2013, EM and DG conceptualized the onboarding intervention program Healthy Study Start and have been applying it in various study programs since 2013. AL conceptualized the evaluation study, was responsible for the data acquisition, interpretation of results, and drafted the paper. DG was responsible for the description of the intervention program Healthy Study Start and gave feedback on the manuscript. AL and MM were responsible for the data analysis and contributed to the drafting of the manuscript. EM participated in the conceptualization of the study and provided feedback. All authors have approved the final version of the paper.

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Mental Well-Being in UK Higher Education During Covid-19: Do Students Trust Universities and the Government?

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This paper draws upon the concept of recreancy to examine the mental well-being of university students during the Covid-19 pandemic. Briefly, recreancy is loss of societal trust that results when institutional actors can no longer be counted on to perform their responsibilities. Our study of mental well-being and recreancy focuses on the role of universities and government regulators within the education sector. We surveyed 600 UK students attending 161 different public higher education providers in October 2020 during a time when many UK students were isolated in their residences and engaged in online learning. We assessed student well-being using the Short Warwick-Edinburgh Mental Well-being Scale (scored 7–35) and found the mean score to be 19.9 [95% confidence interval (CI) 19.6, 20.2]. This level of well-being indicates that a significant proportion of UK students face low levels of mental well-being. Structural equation modeling (SEM) analysis indicates that high recreancy—measured as a low trust in universities and the government—is associated with low levels of mental well-being across the student sample. While these findings are suggestive, they are also important and we suggest that government and university leaders should not only work to increase food and housing security during the Covid-19 pandemic, but also consider how to combat various sector trends that might intensify recreancy.

Keywords: food security, housing security, recreancy, ecological disaster, lockdown

INTRODUCTION

The negative impact of the Covid-19 pandemic on the mental well-being and mental health of university students is serious and a growing concern (1–3). Low levels of mental well-being can reduce motivation, diminish concentration and hinder academic attainment [(4); except see (5, 6)]. Moreover, low levels of student mental well-being can also be a major factor in self-harm and suicide ideation (7). Previous studies suggest that factors such as race, gender, age, and financial strain are likely associated with student mental well-being (8, 9). While there is strong reason

to suspect that the impact of these established factors on well-being are intensified during the Covid-19 pandemic, few studies have examined university student mental well-being and the role of institutional trust during the Covid-19 pandemic. That is, the Covid-19 has served as a reminder that social institutions such as education cannot be counted on to attenuate what Brown [(10), p. 1] labels an "ecological disaster." As a result, in this work we draw upon a social-psychological perspective to argue that contemporary studies of student mental well-being should account for student trust in their university and government to ensure their mental well-being during the Covid-19 pandemic. To make this connection we draw upon Freudenburg's [(11), p. 915–916] concept of recreancy that we employ by measuring perceptions of trust in universities and government regulators to understand risk management associated with low levels of student well-being during Covid-19. Specifically, recreancy is "a retrogression or failure to follow through on a duty or trust" [(11), p. 916]. Staying true to Freudenburg's original conception of recreancy we do not lay blame on any institutional actors. Instead, the purpose of this research is to determine whether and how student levels of trust in two important actors in the education sector during Covid-19 may impact student mental well-being.

The current research is divided into five sections. First, we examine the concept of recreancy to demonstrate how it is relevant to ecological disasters such as Covid-19. Next, we examine the literature on student well-being, situating the concept of recreancy alongside important predictors of well-being to propose a model of student well-being during Covid-19. Third, we explain data collection and methods for testing our model of student well-being. In that section we draw upon a survey of 600 students currently enrolled in universities across the UK. The fourth section of this manuscript describes the findings of the research. Specifically, we discover trust is correlated with mental well-being but also appears to be shaped by food and housing insecurity as well as social and economic circumstances. Finally, we conclude by suggesting that recreancy, as operationalized by asking whether students trust their university and the government, is likely to be a critical variable in studies of student well-being during ecological disasters such as the Covid-19 pandemic.

ECOLOGICAL DISASTERS AND RECREANCY

One view of the current pandemic is that it is an anthropogenically-driven ecological disaster that has arisen because of technological advances in agriculture. In short, the modern world provides an ideal environment for emerging pathogens that can lead to such disasters. Brown (10) explains:

> As cities and farm operations grew, people and animals crowded closer together. The result was a new epidemiological order, in which zoonotic diseases—ones that could jump from animal to human—thrived. At first, these diseases remained confined to the places where they originated. [However]…infectious diseases have broken out more than twelve thousand times over the past three decades. It's no small feat to cross the species barrier; these numbers speak to the scale of our agricultural system.

Thus, the interconnectedness of biological lives makes it likely, if not inevitable, for pandemics such as Covid-19 to occur. In particular, those advances in agriculture technology have allowed for unprecedented levels of food production and, when combined, global travel and trade can contribute to the creation of an ecological network that binds us all together and lay the groundwork for ecological disasters (see (12, 13)).

It is within the context of ecological disaster that we draw upon Freudenburg's concept of recreancy [see also (14)]. Freudenburg (11) developed his theory of recreancy by drawing upon Durkheim's (15) theory of the division of labour, or the notion that societies are increasingly held together organically as occupational specialisation increases. While the division of labour is responsible for important technological advances, it is also simultaneously problematic (11). That is, "the very division of labour that permits many of the achievements of advanced industrial societies may also have the potential to become one of the most serious sources of risk and vulnerability" [(11), p. 914]. The implications of this unintended consequence specialisation are not only that technological disasters occur, but in Freudenburg's words that "natural forces" overcome institutional defenses that are no longer reliable. In short, social institutions are not trusted because institutional actors fail to carry out their obligations. While recreancy research tends to focus on the actors within institutions, Freudenburg believed in a more nuanced approach that linked these actors to their social institutions. Thus, Freudenburg (11, 16) conceived of recreancy as the deterioration or lack of trust in social institutions. This institutional focus allowed Freudenburg to maintain that recreancy was not about blaming institutional actors.

> It is not relevant to know whether or not villainy can be discerned, whether at individual or collective levels; instead, to repeat Weber's words, the key question is simply whether experience shows that the behaviors of specialized individuals and institutions can be counted on [(11), p. 917].

We apply the concept of recreancy to the educational sector because it is often viewed as taking a major role in student "duty of care" and ensuring student well-being (17, 18). In short, the university has a direct impact on the lives of many students (19, 20). In the UK, universities have been under pressure for their response to Covid-19. For instance, the media has widely reported that students believe universities have failed to protect their well-being during lockdown (21–24). This pressure has led to a public outcry that the higher education sector cannot be trusted. For example, Manchester University was forced to publicly apologise "for the concern and distress caused" to students after university officials surrounded resident halls with guarded metal barriers during the night to keep students segregated (25). Anecdotally, students across the country have reported that they cannot count on universities during the Covid-19 crisis. As one student succinctly put it, "We were lied to" [(26), para 8]. Other students extend

blame to government regulators who do not carry out their university oversight responsibilities and instead allow universities to freely take advantage of students. Moreover, some higher education advocates even suggest that the government has failed to provide universities with appropriate guidance and financing which leaves universities little choice but to exploit their own student populations. For example, one journalist observed, the "government has yet to show [universities] the sort of crisis support it tried to extend, for example, to the hospitality industry" [(26), para 7]. In the wake of these events students' advocate groups have called for additional help and students have engaged in organised protest activities ranging from rent strikes to virtual direct action by highlighting their grievances like food insecurity or prison-like living conditions to shame universities (22). More recently, students have organized a call for tuition and rent refunds as well as better access to campus facilities and student health and well-being support (22, 23, 27). In this research we suggest that whether the university and its regulators can be "counted on" during an ecological crisis such as Covid-19 has important implications for the mental well-being of students.

Unsurprisingly, there have been few studies of recreancy among university students. One notable exception is research by Ladd et al. [(28); see also (29)] into the relocation of nearly 50,000 New Orleans college students during Hurricane Katrina, a large Category 5 hurricane that struck southeastern United States in August 2005. Ladd et al. (28) discovered that students were filled with perceptions of recreancy, especially in relation to the government's response to the disaster. As the researchers report, "about six out of 10 students stated, based on their disaster experiences, they did not trust President Bush, FEMA (i.e., Federal Emergency Management Agency), the federal government, or the Louisiana state government" [(28), p. 64], with one university student summing up their feelings of recreancy as follows: "FEMA is a joke!" (p. 66). Students in the study reported that they "distrusted the federal government, even more than before" and could not "count on any politician." While Ladd's study was appropriately focused on the trust of state and federal government response to relocating students during the Katrina disaster, we focus on recreancy by asking about trust in higher education and its operational response during Covid-19.

Despite the scarcity of research on student recreancy, the concept has been applied to a variety of technological and natural disasters (30–37). As Ritchie et al. [(36), p. 657] observe, recent scholars have noted, recreancy "offers important insights into social impacts such as loss of social capital and civility, as well as psychological responses of frustration, anger, and hostility frequently associated with these types of events" [see also (14, 38)]. While scholars have examined recreancy with respect to potential community impacts that disrupt and harm social relationship and create civil disorder there have been no studies, of which we are aware, that examine the concept of student recreancy during the Covid-19 pandemic. Thus, our examination of mental well-being is social-psychological in that we hypothesise that students experiencing high levels of recreancy, and therefore low levels of trust in the university and its regulators will also have lower levels of mental well-being than students who have high levels of trust in these two sets of actors.

PREDICTING STUDENT MENTAL WELL-BEING

The World Health Organization (39) states, "mental health is not just the absence of mental disorder [but] as a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work." Mental well-being is the experience of health and prosperity. It includes having good mental health, high life satisfaction, a sense of meaning or purpose, and an ability to manage stress (40).

In our review, we highlight research that directly measures well-being or its components, and mental health difficulties that could aid or disrupt an individual's potential. Previous research has overwhelmingly suggested that a variety of factors such as financial strain, gender, race and age, housing security and food security may impact well-being (9). We review these factors below prior to presenting our integrated model of student recreancy and well-being during Covid-19.

Financial Strain

A number of studies have examined the economic circumstances and mental well-being of university students. Among the most studied variables are student financial pressures, which are likely to decrease mental well-being. For instance, university students who come from lower socioeconomic status households often face more financial strain and therefore have higher rates of mental health problems and lower levels of mental well-being than do those who come from more affluent households (41). In a study of Australian students, Stallman (42) found that students who identified as having any level of financial stress were much more likely to report decreased subjective mental well-being when compared to students with no financial stress [see also (43–45)]. In a recent UK study, Benson-Egglenton (46) found a clear relationship between students' mental well-being and financial circumstances. That is, students who faced financial hardship had lower levels of mental well-being. Benson-Egglenton reported that students who had higher well-being scores on the Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS) were less likely to need a student loan, more likely to receive financial support from their parents and less likely to be in debt when compared to those who had lower well-being scores.

Gender

Male and female students have also been identified as having different levels of well-being. Female students are more likely to self-report symptoms consistent with mental illness than their male peers (41, 47, 48). In addition, female students are more likely than male students to perceive various academic, friend and work scenarios as stressful (49) which may impact mental well-being. Moreover, research on student well-being suggests that female students have lower levels of mental well-being than males and are also more likely to suffer from distress, including more somatic symptoms and anxiety/insomnia (47) which might be

linked to academic performance. In particular, women in male-dominated fields of study are more likely to feel pressure to conforming to the gender stereotypes (i.e., "stereotype threat"), which is associated with poor mental health (50).

While considerable evidence exists that female students are more at risk of low levels of mental well-being than male students, a number of studies on gender and well-being are inconclusive. Lee and Loke (51) find that male students participate in more pro-health type behaviours than female students but that no gender differences in psychosocial well-being exist [(51); see also (52)]. Nevertheless, El Ansari et al. [(53), p. 293] found that even while females were more likely to rate well-being higher than males, they were also "more likely [than males] to feel psychosomatic/physical health problems … [and] … more likely to feel burdened overall."

Race/Ethnicity

White university students have higher levels of mental well-being (54) and lower levels of psychological distress (55) than other students. Wang and Castañeda-Sound (56) discovered ethnic minority students tended to feel less satisfied with life and experienced more stress than white students. Moreover, ethnic minority students often report having higher levels of stress and lower levels of mental well-being than white students, suggesting a potential correlation between stress and well-being (57, 58). The finding that ethnic minority students experience lower levels of mental well-being than white students is often reported in the literature, and there may be reasons for this finding other than stress (59–61). For instance, as is the case with stereotype threats faced by women, ethnic minority students may feel significant pressure to reject group stereotypes (62). Steele (63) discovered that being under threat of judgement by a racial stereotype leads to impaired performance on tests and is associated with lower levels of mental well-being. Other research suggests that ethnic minority students might experience low levels of mental well-being and higher levels of mental illness because of the university campus climate or existing institutional prejudice and discrimination (64–67). In a study of first year medical students Hardeman et al. (9) compared African American students to white students and found that African American students had nearly twice the risk of being classified as having symptoms of depression and anxiety. In short, the harmful social stereotypes and discrimination are likely to contribute to lower levels of mental well-being among non-white students.

Age

Research suggests that young people are disproportionately impacted by low levels of mental well-being when compared to other ages (68). In addition, most studies of university student mental well-being that control for age suggest that students face a decline in their mental well-being in their first year of study (5). Older university students are more likely to seek help for mental health problems (41). While age seems to be a factor in mental well-being, some studies do not find a relationship between age and outcomes related to mental well-being, such as stress [e.g., (47)]. In addition, a few studies [e.g., (69, 70)] suggest there is a negative correlation among age and factors associated with mental well-being perhaps because older students (e.g., those typically in post-graduate school) are sometimes identified as being more sleep deprived (71) or are more likely to suffer from academic burnout (72). Finally, some research finds that age and gender may interact in that age only matters for female students, where older students report higher levels of mental well-being than younger students (73).

Food/Housing Insecurity

Both food and housing insecurity are believed to be related (74) and predict low levels of mental well-being (75–82). Moreover, some students may even sacrifice basic food and housing needs to pay university tuition and fees. Food insecurity exists when there is insufficient or inappropriate access to food, while housing insecurity occurs when housing is unstable, unaffordable, unsafe or unavailable (83). There is growing recognition that food insecurity is tied to mental well-being on university campuses and many researchers are starting to conclude that food insecurity is likely to be a consistent and main factor associated with anxiety and depression among university students (84–87). A recent systematic review of 58 empirical studies from countries across the globe suggest that nearly one-third of university students may be food insecure and it is likely that that they suffer from "poorer nutritional outcomes, higher stress and depression and adverse learning, academic outcomes and/or productivity" as a consequence [(88), p. 1,780; see also (89)].

While housing insecurity is less studied than food insecurity among student populations it is, nevertheless, often mentioned in studies of student mental well-being (90). Moreover, in countries like the United States, 11–19% of undergraduate students are housing insecure [(91); see also (83)] and these rates are increasing (92). Importantly, Leung et al. (90) found that students who were facing housing insecurity were nearly twice as likely to report on a patient health questionnaire that they faced anxiety and depression, two conditions that negatively impact mental well-being.

Finally, it must be noted that food and housing insecurity are likely to impact well-being but are also likely to be strongly related to other important factors. For instance, financial strain is likely to have an important and direct impact on both housing and food insecurity (93–97) among students, which are also likely to impact mental well-being (98). Students who receive student loans are also more likely to be food insecure (74, 99) while those who have competing financial obligations are more likely to face food insecurity (100). Raskind et al. (98) found that students whose parents have less than a high school education, are receiving benefits and have lower discretionary budgets are more likely to identify as food insecure. Those studies that have been conducted suggest that poverty and financial stress leads to increased anxiety and poor mental health (41). Moreover, it is increasingly clear that marginalized students are particularly at risk. That is, non-white (101, 102), multiethnic (103), female [(95, 104), but see (98, 101)], Lesbian, Gay, Bisexual, Transgender, Queer (LGBTQ) students (105) are disproportionately food insecure when compared to white males.

TABLE 1 | Hypotheses (paths) tested in university student mental well-being model.

Hypothesis	Selected Literature
Financial Strain has a direct influence on mental well-being. Students who come from households that are financially strained are likely to face lower levels of mental well-being than students who come from households who have not faced economic disadvantage (H1).	El Ansari et al. (44), Benson-Egglenton (46), Eisenberg et al. (41), Lange and Byrd (43), Mulder and Cashin (45), and Stallman (42)
Gender has a direct influence on mental well-being. Female students will have lower levels of mental well-being than male students (H2).	Day and Livingstone (49), Eisenberg et al. (41), Saleh et al. (47), except see El Ansari and Stock (52), and Lee and Loke (51)
Race/Ethnicity has a direct influence on mental well-being. White students will have higher levels of mental well-being than other students (H3).	Aronson et al. (62), Ben-Ari and Gil (59), Blaine and Crocker (60), Cokley et al. (58), Dyrbye et al. (54), Griffith et al. (57), Hardeman et al. (9), Iwamasa and Kooreman (61), Prelow et al. (55), and Steele (63)
Age has a direct effect on mental well-being. Older students will have higher levels of mental well-being than younger students (H4).	Pedrelli et al. (68), except see Galbraith and Merrill (70), Saleh et al. (47), and Voltmer et al. (69)
Food and Housing Security will have a direct influence on mental well-being. Students who are food insecure will have lower levels of mental well-being (H5). Students who are housing insecure will have lower levels of mental well-being (H6).	Broton and Goldrick-Rab (78), Frongillo et al. (79), Heflin and Ziliak (75), Howell and Howell (76), Jones (80), Lee (81), Payne-Sturges et al. (74), and Stahre et al. (77)
Trust in Government will have a direct influence on student mental well-being. Students who trust the government to protect their health during the pandemic will have higher levels of well-being than students who do not trust the government to protect their health during Covid-19 (H7).	Freudenburg (11, 16)
Trust in their University will have a direct influence on student mental well-being. Students who trust their university to protect their health during the pandemic will have higher levels of mental well-being than students who do not trust their university to protect their health during Covid-19 (H8).	Freudenburg (11, 16)

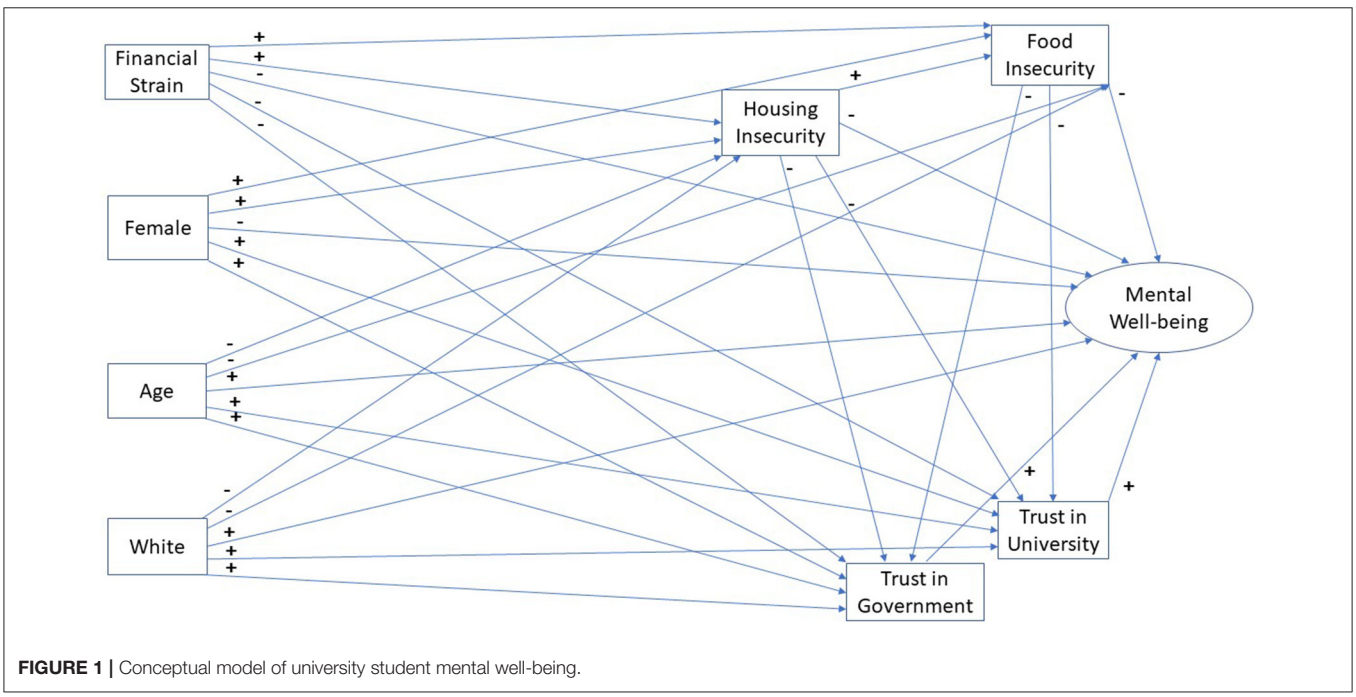

FIGURE 1 | Conceptual model of university student mental well-being.

METHODS

Sampling and Data Collection

Research on recreancy and predictors of student mental well-being generated a set of hypotheses in **Table 1** to be tested in this study. We are especially interested in examining the relationship between institutional trust and mental well-being within the context of the existing literature on student mental well-being. **Figure 1** summarises the predicted relationships in the literature along with variables on institutional trust.

The findings presented in this research are drawn from a cross-sectional sample of UK university students administered during the Covid-19 pandemic. Following ethical approval from the Faculty of Arts, Design and Social Sciences Ethics Committee at Northumbria University (reference number: 22790) a sample of 600 students was obtained with the help

of *Prolific* (www.prolific.ac), an online survey platform that connects researchers to participants and is often used for social and economic research (106). Out of the 600 students who responded to the survey, 133 students did not provide answers to all the survey questions. As a result, the total sample size for this study is $n = 467$ students. We provide a breakdown of missing cases by variable in Appendix A (**Supplementary Material**) along with descriptive statistics for the variables included in our analysis (described below). Specifically, *Prolific* selected the student sample from a population of 4,758 eligible students who were immediately available to enroll in the research on a first-come, first-served basis. All participants received £1.50 compensation for their time to complete the short questionnaire that consisted of 38 close-ended questions. The questionnaire took <10 min to complete and was administered between 27 and 28 October 2020.

In 2018/2019 the UK Higher Education Statistics Agency reported that 2.38 million students were enrolled at 169 public higher education providers across England, Northern Ireland, Scotland and Wales. In the current study, the student sample consisted of 600 students from 161 public higher education and alternative providers in the UK. 93.5% of these students were undergraduates. Overall, the sample was 64% female (vs. 64% of undergraduates in the public university population in 2018/2019), 62% white (vs. 75% of undergraduates in the public university population in 2018/2019), 49% were under 21 years of age (vs. 57% in the undergraduate university population in 2018/2019), 22% report that they had received means-tested, free school meals during secondary education (vs. 19% who came from the most deprived areas of the UK in 2018/2019) and 45% reported that they were first generation HE students (vs. 50% in the university population in 2018/2019)[1] Notable, then, the sample of students in this study appears to reflect the UK population of undergraduates with some amount of accuracy.

Mental Well-Being

The primary dependent variable in the current study is mental well-being that is measured with the Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS). The SWEMWBS has been widely used by researchers studying mental well-being [e.g., (107–111)] and measures the positive aspects of mental health. The scale assesses mental well-being using a 5-point Likert scale (1 = "None of the time," 2 = "Rarely," 3 = "Some of the time," 4 = "Often," 5 = "All of the time") on seven questions with an overall outcome score ranging from 7 to 35. All SWEMWBS scores were transformed using the published metric conversion recommended by Stewart-Brown et al. [(112), para 22]. Higher scores on the SWEMWBS are indicative of greater mental well-being. The SWEMWBS has been used to study student populations and is correlated with other scales measuring overall health, physical well-being, life satisfaction and emotional intelligence (108, 113, 114). Moreover, past research has found that in 2011 mean SWEMWBS scores for 16- to 24-year-olds in the English population ranged between 23.2 for women and 23.6 for men (108). The mean SWEMWBS score in the current sample is 19.9. While comparisons are difficult to make across diverse populations and time periods it is not surprising that the mean SWEMWBS score in the current sample is somewhat lower than reported in previous studies. Moreover, in the current study the SWEMWBS showed good internal consistency, with a Cronbach's alpha value of 0.86 in the sample. Appendix B in **Supplementary Material** lists the results of the confirmatory factor analysis for the mental well-being scale. As noted, the scale had factor loadings that ranged from 0.500 to 0.797.

Recreancy

We measure recreancy as the amount of trust students place in their university and government to ensure their general well-being during the Covid-19 pandemic. To measure recreancy, we rely on two specific questions about trust: (1) "I trust the university to look after my well-being during the coronavirus pandemic" and (2) "I trust the UK government to ensure that my university will look after my well-being during the coronavirus pandemic." Responses to these two questions are scored from strongly disagree = 1 to strongly agree = 5. In particular, the mean (median) for trust in the university is 3.35 (3.0) with 7.8% of students reporting that they strongly disagree that they trust that their university is working to ensure their well-being and 14.5% of students reporting that they strongly agree that they trust that their university is working to ensure their well-being. Overall, just over 25% of students disagree or strongly disagree that their university will look after their general well-being during the Covid-19 pandemic. The mean (median) scores for trust for government to regulate UK universities to promote student well-being is low as the mean score for this question is 2.3 (2). Nearly 31.7% of students strongly disagree that they trust the UK government to ensure their university will look after their general well-being while only 4.3% strongly agree that they trust the government to ensure that the university will look after their general well-being.

Financial Strain

We use free school meal (FSM) status to identify students who are likely to come from households that are facing financial stain. In the England and Northern Ireland, pupils who are at least 7 years of age qualify for free school meals when the adults in the household claim one of several types of state benefits, including social security benefits in the form of income support, jobseeker's allowance, income related employment support, child tax credits, working tax credits and/or universal credit. In the case of universal credit, applicants must demonstrate an annual net earned income of £7,400 or less in England or £14,000 or less in Northern Ireland to receive FSM (115). While there are various potential measures of financial strain, Gorard [(116), p. 1,014] suggests that in the UK, using FSM as an indicator of poverty or financial hardship is "currently better than the alternatives…such as…household income, home resources, parental occupation(s) or social class." Taylor (117) also suggests that while parental education, occupation and income are likely to be the best

[1]Population estimates derived from *Higher Education Student Statistics: UK, 2018/19 – Student Numbers and Characteristics* published 20 January 2020. Available online at https://www.hesa.ac.uk/news/16-01-2020/sb255-higher-education-student-statistics/numbers.

indicators of socio-economic disadvantage, researchers should be cautious about recommending replacing FSM eligibility for other alternative indicators of economic hardship as those indicators are often difficult to collect and the gain in predictive power is modest. In the present study we believe it is unlikely that many students would be unable to accurately report the household income of their parents and caregivers. As a result, we employ the relatively simple measure of FSM to identify those students who have come from households that are likely to face economic hardships. We measure financial strain by asking students whether they received FSM in their last year of secondary school. Students who come from households that face economic hardship are therefore eligible for FSM are also likely to face financial strains at university where they often rely on support from their family [see (46)]. Students scored "1" on the financial strain variable if they come from a household that received FSM in secondary school, while those who did not receive FSM were scored "0" on that variable.

Gender

To capture the relationship between gender and mental well-being identified in the literature we measure gender using a dichotomous variable. Students were asked to report their gender (i.e., "female," "male," "non-binary," "third gender," or self-described). In our analysis female, non-binary, third gender, and self-described students were scored "1" while male students were scored "0." As an alternative operationalisation of gender, we also compared female students (scored as "1") to all other genders scored as "0." We estimated a model for each operationalisation of gender and found that the models were nearly identical (not shown). That is, the alternative methods of measuring gender had no impact on this analysis as the coefficients, standard errors, and goodness of fit statistics were identical in both models.

Race/Ethnicity

Students' Race/Ethnicity was measured using a 15-category nominal level variable. Results were largely clustered in White British category (i.e., White English/White Welsh/White Scottish/White Northern Irish/ White British) and spread evenly with relatively low frequencies (n = 4–23) among most other categories (e.g., African, Bangladeshi, Black British, Caribbean, Chinese, Indian, Pakistani, White, and Asian). As a result, we created the dichotomous variable where White UK students were scored 1 and students of all other races and ethnicities were scored 0. This variable therefore measures self-identified race/ethnicity categorized into white/non-white which likely is associated with social advantages.

Age

Age is a ratio level variable that represents the student's age in years. The mean (median) student age was 23.0 (21.0) years old with a standard deviation of 6.5 years.

Food Insecurity

Food insecurity was measured using the US Department of Agriculture's 6-item food security scale [see (95)]. The questions that made up the scale asked students to recall whether the following happened since the start of the Autumn 2020 term: (1) "The food that I bought just didn't last, and I didn't have money to get more"; (2) "I couldn't afford to eat balanced meals"; (3) "Did you cut the size of your meals or skip meals because there wasn't enough money for food?" and if "Yes"; (4) "how often did this happen?"; (5) "Did you ever eat less than you felt you should because there wasn't enough money for food?" and (6) "Were you hungry but didn't eat because there wasn't enough money for food?" The possible responses to questions 1 and 2 were "never," "sometimes," or "often," while the responses to questions 3, 5, and 6 were "yes" or "no." Finally, the responses to question 4 was "almost every month," "some months but not every month," or "only 1 or 2 months." Responses of "often" or "sometimes" on questions 1 and 2, and "yes" on questions 3, 5, and 6 were scored as 1. Responses of "almost every month" and "some months but not every month" on question 5 were scored 1. All other non-missing answers were scored 0. The sum of these six items ranged from 0 ("food security" -—52.8% of all students) to 6 ("very low food security" -—7.1% of all students). The mean (median) food insecurity score was 1.4 (0). Cronbach's alpha for the food insecurity scale is 0.88, suggesting high internal consistency for this variable.

Housing Insecurity

Housing insecurity was measured by asking students the extent to which they agreed with the following statement since the start of the Autumn 2020 school term: "I am finding it difficult to pay my rent or mortgage." Responses to this item ranged from 1 = Strongly Disagree to 5 = Strongly Agree. The mean (median) housing insecurity score was 2.5 (2.0).

Analytic Strategy

Building on previous research, the purpose of the current study is to present a conceptual model of student mental well-being during the Covid-19 pandemic. As previously suggested, we hypothesise that recreancy, measured as trust in the University and Central Government, play an important role in shaping levels of student mental well-being. To carry out our analysis we estimated the structural equation model (SEM) presented in **Figure 1** testing the hypotheses described in **Table 1**. We choose to use SEM because the literature suggests the relationships between food security, housing security, gender, race, age and economic status are complex and can take various paths to mental well-being. In addition, we believe that the focus by UK students on food and housing security is central to predicting student trust in their university and the government. In short, the SEM provided us with a method to present relatively complex relationships where is more than one dependent variable in a parsimonious fashion.

The SEM was estimated using the Stata 15 sembuilder function for 467 students for whom all information was available. We use maximum likelihood estimations (without imputation or deletion). As previously noted, scales for food insecurity and mental well-being are acceptable. We assess the model fit using

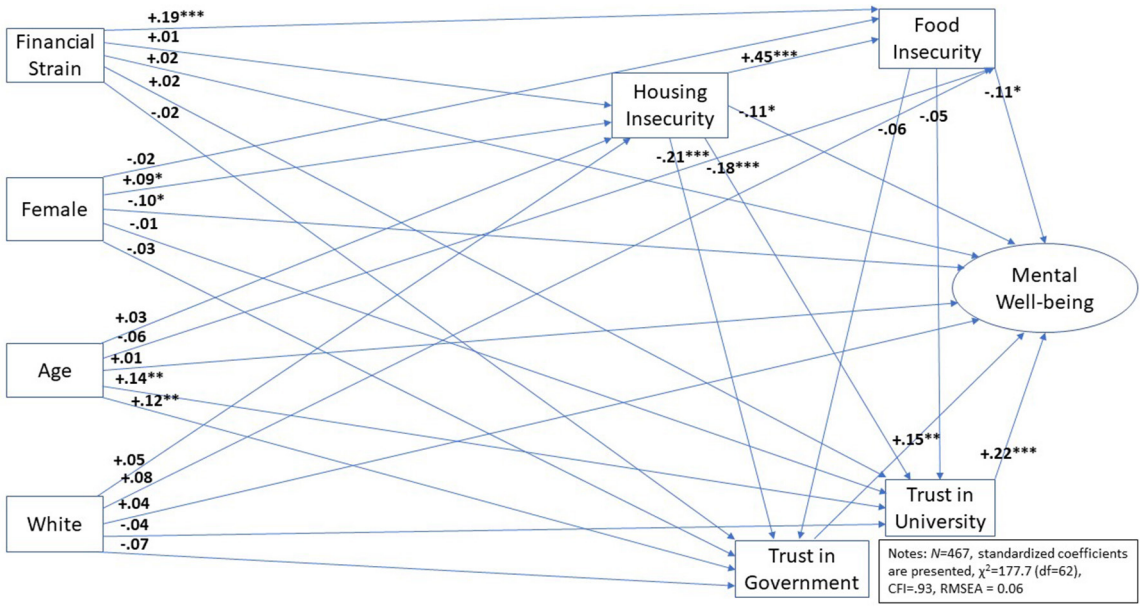

FIGURE 2 | Empirical model of university student mental well-being. *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.

the Root Mean Square Error of Approximation (RMSEA) and the Comparative Fit Index (CFI).

RESULTS

The descriptive statistics and bivariate correlation coefficients for the variables and scales in the analysis are in Appendix A (**Supplementary Material**). Those bivariate correlations indicate that student mental well-being is correlated with the food insecurity scale and three variables (housing insecurity, trust in their university and trust in government). An increase in food insecurity or housing insecurity across the sample of students is associated with a decrease in mental well-being. In addition, as trust in their university or trust in the government to regulate their university increases across students, student mental well-being also increases. Despite previous research findings on race, gender, past financial strain and age, none of these variables are associated with mental well-being in those bivariate correlations. However, we do observe that female students are more likely to face housing insecurity than male students. We also find that white students are less likely to trust the government than non-white students. Finally, we observe that higher levels of food insecurity and housing insecurity are associated with lower levels of trust in the university and lower levels of trust in the government. In short, the bivariate correlations suggest that student trust in the university and government are important, if not critical, variables in predicting student mental well-being.

Figure 2 presents the SEM hypothesised in **Figure 1**. Overall, the chi-square (χ^2) for the model is 177.7, which is statistically significant ($p < 0.05$) and leads us to reject the null hypothesis that the observed and predicted models are equal. However, chi-square is highly sensitive to sample size and not recommended for use with samples as large as the one in the current study (118). As a result, we examine model goodness of fit using the comparative fit index (or CFI) and the root mean square error of approximation (or RMSEA). We choose the CFI because it is not sensitive to sample size and compares the fit of the observed model to the baseline model where all variables are uncorrelated (119). The CFI for the model in **Figure 2** is 0.93, well above the acceptable benchmark value of 0.90 (120), equal to the value recommended by Byrne (121) and near the conservative benchmark of 0.95 recommended by Hu and Bentler (122). The RMSEA is a parsimony-adjusted absolute fit indicator that examines whether our specified model in **Figure 2** reproduces the sample covariance matrix. The RMSEA for the model is 0.06, which is appropriately below the 0.08 benchmark value (122) and near the ideal 0.05 value recommended by Steiger (123). Finally, it is worth pointing out that when the chi-square statistic for model fit ($\chi^2 = 177.7$) is divided by the model degrees of freedom ($df = 62$) as a relative adjustment for sample size, the result is 2.87. This value is near the ideal value of 2 recommended by Ullman (124) well below the common cut-off value of 5 recommended by Schumacker and Lomax (120). In short, the model in **Figure 2** appears reasonable.

The hypotheses presented in **Table 1** are evaluated in **Figure 2**. When we examine the direct effects of financial strain, gender, age, and race/ethnicity on mental well-being (Hypotheses 1–4) we only find modest support for Hypothesis 2. That is, looking across students in the sample, female students tend to have slightly lower levels of mental well-being than male students ($\beta = 0.10, p < 0.05$). Turning to the relationship between food security, housing security and mental well-being (Hypotheses 5 and 6) we find that increasing levels of housing security are associated with decreased levels of mental well-being ($\beta = -0.11, p < 0.05$) and

increasing levels of food insecurity are associated with decreasing levels of well-being ($\beta = -0.11$, $p < 0.05$). Thus, both hypotheses are supported.

Hypotheses 7 and 8 examine the impact of recreancy as measured through the variables trust in the university and trust in government university regulators. **Figure 2** suggests that trust in the university is positively correlated with mental well-being. As students report that they trust their university to look after their mental well-being, their subjective well-being scores increase ($\beta = 0.22$, $p < 0.05$). The same relationship is found between government trust and mental well-being ($\beta = 0.15$, $p < 0.05$). Both relationships support hypotheses (H7 and H8) and suggest that trust has a negative association with student mental well-being. Moreover, student trust in their university and the government has two of the largest effects on mental well-being, suggesting that recreancy is an important aspect of student well-being during the Covid-19 pandemic.

DISCUSSION AND CONCLUSION

There has been a recent call to investigate students' mental well-being during the Covid-19 pandemic (125). Although there have been several investigations into student well-being researchers have yet to examine the potential role of recreancy as measured by examining student perceptions of the failure of institutional actors such as universities and government regulators. As a result, there is a significant gap in current understandings of why some students may have particularly low levels of mental well-being during the Covid-19 pandemic. Our findings suggest that a lack of student trust in universities and government regulators may be an important factor in levels of mental well-being among students during ecological disasters. That is, recreancy appears to be important. While students have likely come to rely, at least partly, on university and government institutions to protect their mental well-being in the past, the perception by many students is that these actors can no longer be relied upon. Our analyses indicates that this form of recreancy could have an impact on student mental well-being.

Unfortunately, like most studies of student well-being our research suffers from some weaknesses. First, our sample is cross-sectional and does not consider how recreancy and mental well-being might have changed over time. As a result, it is difficult to say definitively whether levels of trust are impacted by Covid-19. We must point out, however, that there is pretty clear evidence that food insecurity and housing insecurity, things that should influence trust, have intensified during the Covid-19 pandemic [e.g., see (125–128)].

Second, the cross-sectional nature of our study means that it is not possible to establish causation. In particular, the association between mental well-being modeled in our data could be reversed, such that low levels of student mental well-being give way to low levels of trust. To examine this issue in more detail we tried alternative SEM models where mental well-being was used to predict trust (not shown). However, these efforts failed to produce a better fitting model. Thus, while our approach provides some empirical evidence that trust shapes mental well-being, more research is needed. That is, these findings need to be replicated in other settings and using longitudinal designs to better understand whether the relationship between trust mental well-being.

Third, as this is an observational study rather than experimental study it is possible that the association between mental well-being and trust could be confounded by an important third factor such as personality attributes or academic achievement. For instance, personality attributes such as neuroticism, extroversion, openness, agreeableness and conscientiousness may all influence levels of mental well-being and may also be related to how much faith and trust students place in the university and government during Covid-19. This study did not account for various personality factors that may influence mental well-being and as a result, as is the case with all observational studies, some caution must be exercised when interpreting results.

Fourth, our research is based in the UK, and the finding regarding demographic variables, food insecurity, and housing insecurity on mental well-being are largely consistent with the majority of studies on student mental health and mental well-being across the globe; it remains uncertain whether the mental well-being of higher education students in other countries would be similarly correlated with recreancy. In particular, the present survey was administered during a period of high infection rates and when UK students and young people were being blamed by politicians and media for spreading the virus (129, 130). The consequence of this "blame" may have created a unique situation where student trust or confidence was uniquely related to well-being. Moreover, trust in UK government was also at an all-time low in 2019 with 34% of the population stating that they "almost never" trust government (131). Thus, it is possible that these low levels of trust among the majority of the UK population is relatively unique, perhaps limiting the generalisability of the study results.

In the end, these results suggest that universities across the UK should pay more attention to the potential relationship between trust and mental well-being. Among the more consistent findings in the literature are our results concerning gender, previous financial strain, food security and housing security, all of which have been found to impact mental health and/or mental well-being. Our models also suggest that problems attributed to universities, failure to act such as food insecurity and housing insecurity may increase feelings of recreancy and reduce mental well-being. Thus, we encourage universities to pay particular attention to the relationship between trust, food insecurity, housing insecurity, gender, financial strain, and mental well-being. If these variables are related as we suggest then universities and government should ensure that students have sufficient and appropriate access to healthy, nutritious, and culturally appropriate food, especially during periods of lockdown or self-isolation when many students and their families may be struggling to source food. Moreover, governments and universities might also consider the role of housing insecurity in impacting trust and mental well-being. This is the case because many students report that they feel stuck paying for unaffordable contracts in residences in which they are confined (and unable to leave) and/or living in housing that is unsafe for vulnerable students given the overall numbers of students residing in a property. Finally, while additional investigations

into student trust and mental well-being are needed, we suggest that universities and governments might, nevertheless, consider a communication strategy for improving trust among students to promote mental well-being, especially by noting how they are attenuating food and housing insecurity. Thus, even while we recognise the weaknesses associated with the current investigation, we also suggest that there is strong reason to want to promote gender equality, food, and housing security that are found to be associated with mental well-being among university students. If an outcome of these efforts is to increase student trust in institutional actors in the education sector, all the better.

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 in Arts, Design and Social Sciences at Northumbria University (Reference Number 22790). The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MD contributed to the design, methods, and writing the manuscript. PS and ML contributed to the questionnaire design, data analysis, and writing the manuscript. SF, CR, DP, and AD contributed to the questionnaire design and editing the manuscript. AK, AM, and LG contributed to the questionnaire design and data collection. JF contributed to the data collection. EM contributed to the questionnaire design, data collection, and editing the manuscript. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.646916/full#supplementary-material

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Time Pressure and Health-Related Loss of Productivity in University Students: The Mediating Role of Exhaustion

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Introduction: Being present at work when sick is not just prevalent in employees. Since university is also a demanding context, there is a growing interest in this phenomenon in university students. Especially students with mental health issues show a higher degree of productivity loss. However, little research has examined the causes of these productivity losses—especially in university students. Therefore, we examined health-related (burnout) and non-health-related (time pressure) aspects that lead to productivity losses in the long run.

Methods: We decided to examine the effect from time pressure on health-related loss of productivity, mediated by exhaustion. This assumption is in line with the health impairment process proposed by the Study Demands-Resources (SD-R) framework. To examine this assumption properly, we conducted a longitudinal study with three occasions. We surveyed 392 students in three waves over 1 year and performed structural equation modeling (SEM) to confirm the assumptions longitudinally.

Results: In line with our assumptions, time pressure predicted burnout which, in turn, predicted health-related loss of productivity in the long run. Hence—as assumed by the SD-R framework—burnout serves as a mediator between study demands and negative outcomes such as loss of productivity.

Discussion: Our study is the first that uncovers health-related and non-health-related causes of health-related productivity loss in university students. Thus, we were able to confirm SD-R's health impairment process longitudinally. Since we know that time pressure serves as a major antecedent for burnout and health-related loss of productivity, we are well-advised to establish appropriate interventions to reduce students' time pressure.

Keywords: study demands-resources framework, time pressure, student burnout, health-related loss of productivity, student well-being

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INTRODUCTION

Many people know the feeling of having to go to work even when too sick or stressed to be productive (1). In these moments, they may experience decreased productivity and below-normal work quality (2). This concept is well-known as presenteeism—or a health-related loss of productivity (2). Health-related loss of productivity is a widespread and costly issue: 39% of the EU

workforce work despite being ill (3) and 70% of German employees report having been sick at work on at least 1 day within the previous year (4). However, this phenomenon cannot only be found in workers: there is also growing interest in the health-related loss of productivity in university students (5). Especially students with mental health issues show a higher degree of productivity loss than those with other issues [e.g., physical issues; (5)].

However, there is still little research on the causes of health-related loss of productivity—especially in university students. Therefore, our aim is to investigate the longitudinal relationships between study demands, student burnout, and the health-related loss of productivity among students of a large German university.

In the occupational context, several reasons have been identified for why employees go to work when they are sick, including perceived pressure from colleagues, the worry about career opportunities, or even the fear of termination (1). Most empirical research examining the antecedents of health-related loss of productivity has focused on health-related issues, such as specific conditions (e.g., stress) or overall indicators of self-rated health (6). These studies suggest that poor health is a key indicator for productivity losses in the workplace (7). However, there are also non-health-related issues that have been associated with health-related loss of productivity (6), including the relationship with colleagues (8), job insecurity (9, 10), high workload (1, 11), or time pressure (8). While some of these issues are only relevant in the occupational context, others also apply to the university context. We decided to focus on the relationship between one non-health-related issue (time pressure) and one health-related issue (student burnout), and the outcome of health-related productivity loss.

Time pressure can be understood as an increase in workload resulting in a lack of time and often in a decrease of leisure time (12). It has already been identified as one of the key stressors at university (13–15), which is related to stress and depressive symptoms. For almost two thirds of the students, time pressure is the key stressor of university life (13). Several studies have shown strong relationships of time pressure with student burnout (16, 17). As mentioned above, time pressure has been identified as an antecedent of health-related loss of productivity among employees. However, empirical research on this relationship among university students is missing.

Student burnout is also an important issue regarding students' health and well-being. Especially exhaustion—the initial symptom of burnout, which shows the stressors' effect on the individual stressor—is common among students even when compared to employees that report high rates of exhaustion such as physicians (18). Almost 25% of university students suffer from severe symptoms of exhaustion (19, 20). Burnout is related to impaired health and well-being (21–23), at least cross-sectionally. In the occupational context, exhaustion has been identified as an antecedent of health-related productivity loss (1, 24). However, empirical results on the effect within the university context are missing (18). To clarify the relationship between health-related loss of productivity, exhaustion, and time pressure, we used the Study Demands-Resources [SD-R; (17)] framework (see **Figure 1**). The SD-R framework is an influential theoretical basis to examine salutogenic and pathogenic effects of the study context on students' health and well-being. It is an application of the well-established Job Demands-Resources (25–27) framework to the university context. The framework proposes that poor study program design and excessive study demands lead to student burnout and health problems in the long run, whereas study resources lead to higher student engagement and better performance (17). Study demands are those physical, social, or organizational aspects of studying that require sustained physical or mental effort, and are therefore associated with certain physiological and psychological costs (17, 26). Student burnout is defined as a consequence of extended exposure to specific study demands like intense physical, affective, and cognitive strain (20, 28). The final outcomes of the SD-R framework are various positive or negative health- and performance-related indicators such as life satisfaction, academic performance, health complaints, dropout—or a loss of productivity.

The SD-R framework implies that high study demands increase the risk for student burnout and lead to negative outcomes, such as the health-related productivity loss (17). Lesener et al. (17) were able to validate these essential assumptions cross-sectionally. The framework has also been applied and validated in various occupational and organizational contexts—longitudinally and even meta-analytically. However, within the study context, SD-R's essential assumptions have not yet been tested longitudinally. To examine these assumptions properly, we need studies with at least three occasions.

To our knowledge, our study is the first that examines the longitudinal relationship between time pressure as the major study demand, exhaustion, and the health-related loss of productivity. In line with SD-R's health impairment process—we hypothesize:

Hypothesis 1: Time pressure leads to student burnout over time.
Hypothesis 2: Student burnout leads to health-related loss of productivity over time.
Hypothesis 3: Student burnout mediates the longitudinal effect from time pressure on health-related loss of productivity.

MATERIALS AND METHODS

Study Procedure and Sample

Our study was part of a regular health monitoring survey at a major university in Germany. We invited all students to take part in the study. We surveyed the students on three occasions, each 6 months apart. The time lag of 6 months between each occasion is very common for three wave studies to identify antecedents and outcomes of burnout (27). Our aim was to survey students at the end of the semester before the exam period had started.

We invited 33,267 students to take part in our study. Three thousand four hundred twenty students completed the questionnaire at T1, and 1,245 provided their e-mail address to take part at T2 ($n = 866$) and T3. In total, 392 students completed the questionnaire on all three occasions, resulting in a response rate of 10% at T1, 25,2% from T1 to T2 and 45,3% from T2 to T3. Our final sample consisted of 290 women (74%) and 95

men from all departments of this university (Biology, Chemistry, and Pharmacy, Earth Sciences, Education and Psychology, History and Cultural Studies, Law, Mathematics and Computer Science, Philosophy and Humanities, Physics, Political and Social Sciences, Veterinary Medicine, Business and Economics). The mean age of our respondents was 24.4. years ($SD = 5.5$ years) and they were, on average, in their third year of studying (range = 1–9 years). Differences between longitudinal and cross-sectional participants were examined using t and Chi-Square tests. There were no significant differences between the two groups in either sociodemographic characteristics (age, gender, duration of study, intended degree) or analysis characteristics (time pressure, exhaustion, health-related productivity loss. **Table 1**).

Measures

Time Pressure

To capture time pressure as the major study demand, we used a self-constructed scale that has been successfully applied in various health monitoring surveys at universities [e.g., (19, 29)]. The three items included in the survey identify study demands induced by a subjective scarcity of time (see **Supplementary Material**). All items were answered using a Likert scale ranging from "never" (1) to "always" (6). The internal consistency in our study was $\alpha = 0.80$ (T1).

Exhaustion

To assess student burnout, we used the exhaustion sub-scale of the Maslach Burnout Inventory–Student Form [MBI-9-SF; (20, 30)]. The sub-scale consists of three items (see **Supplementary Material**). The frequency of these experiences is scored from "never" (0) to "daily" (6). The sub-scale's mean score is computed, and high scores are indicative of higher student burnout. The factorial validity of the abbreviated MBI-SF scales has been confirmed (20), and the internal consistency of the sub-scale in our study was $\alpha = 0.83$ (T1).

Health-related Loss of Productivity

To capture the health-related loss of productivity, we applied the Stanford Presenteeism Scale (SPS) developed by Koopmann et al. (2). This instrument, adapted for students, measures the health-related loss of productivity within the university setting (2). We used five items of the SPS (see **Supplementary Material**). All items were answered using a Likert scale ranging from "does not apply at all" (5) to "applies completely" (1). The internal consistency of this scale in our study was $\alpha = 0.94$ (T1).

Data Analysis

To test our hypotheses, we performed structural equation modeling (SEM) using Mplus version 8.4. As recommended by Hu and Bentler (31), we assessed the models' goodness of fit by Tucker–Lewis Index (TLI), and Comparative Fit Index (CFI), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR). TLI and CFI are less sensitive to the number of observations. An RMSEA value of <0.06 and a SRMR value of 0.08 or lower indicate good model fit (32). For TLI and CFI, values of 0.90 may be interpreted as an acceptable fit (33).

To test the longitudinal effect of time pressure on health-related loss of productivity mediated by exhaustion, we used the data of a three-wave survey. We examined the temporal relationships between time pressure, exhaustion, and health-related loss of productivity using cross-lagged panel models (CLPM). CLPM are most popular for examining temporal associations between three variables (34), since they control for several biases (i.e., the stability of the variables, cross-sectional associations, and prior associations between the variables). To test mediation models properly, CLPM with three occasions are favorable (34). Therefore, we followed the guidelines for mediation models for longitudinal data made by Preacher (34) (see **Figure 2**).

First, we specified a model (M0), which only included the autoregressive effects of the three variables over time. In a second model (M1; see **Figure 2**) we added the paths of interest as follows: we included the cross-lagged paths from time pressure (T1) to exhaustion (T2) and from exhaustion (T2) to health-related loss of productivity (T3). The causality would be additionally supported if the time-lagged paths from exhaustion (T1) to health-related loss of productivity (T2), and from time pressure (T1) to exhaustion (T2) would be significant (see **Figure 2**: dotted lines). Then we evaluated two alternative nested models, one model with reversed causal effects (M2, see **Supplementary Material**) and one model with reciprocal effects (M3, see **Supplementary Material**). We compared the nested models (M0-M3) using the Akaike Information Criteria (AIC). The proposed model including our hypotheses (M1) should have a lower value than the model including only autoregressive paths. Additionally, we used indirect effect size estimates to confirm whether exhaustion serves as a (complete or partial) mediator between time pressure and health-related loss of productivity. Therefore, we added a direct path from time pressure (T1) to health-related loss of productivity (T3). If this path becomes significant and the model fits the data better, we can assume a partial mediation (35). If the model fits the data worse, we can assume a full mediation.

RESULTS

Means, standard deviations, and correlations of the study variables are reported in **Table 2**. The correlation matrix of the manifest variables used for the analyses can be found in the **Supplementary Material**.

Measurement Model

We specified and tested the measurement model of all latent constructs shown in **Figure 2** prior to model testing. All constructs were assessed by 3–5 items. The overall measurement model with all manifest variables (time pressure, exhaustion, and health-related loss of productivity) on all occasions showed an acceptable fit (χ^2 (459) = 1,009.11, $p < 0.01$; RMSEA = 0.06; SRMR = 0.04; TLI = 0.94; CFI = 0.94. All items loaded solidly on their respective factors ($0.71 \leq \beta \leq 0.92$; $p < 0.001$). To test measurement invariance over time, we introduced measurement-time-specific factors for time pressure, exhaustion, and health-related loss of productivity across the

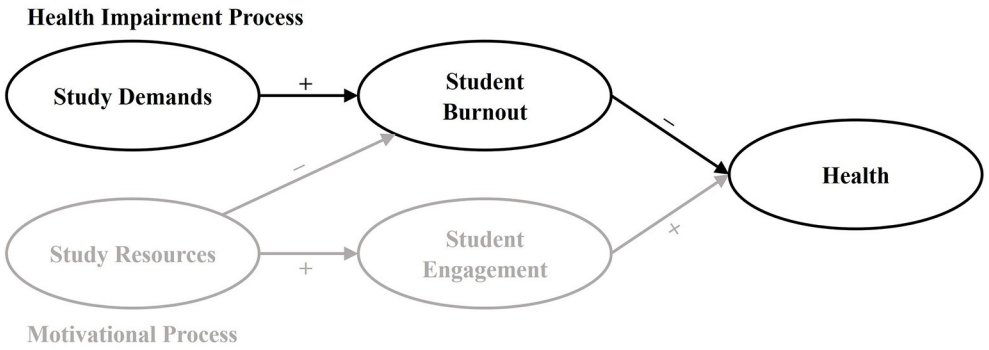

FIGURE 1 | The study demands-resources (SD-R) framework.

TABLE 1 | Means, standard deviations, and differences in age, gender, duration of study, time pressure, exhaustion and health-related loss of productivity between cross-sectional and longitudinal participants at T1.

		T1 (*N* = 3.025)		T1-T2-T3 (*N* = 392)				95% CI	
		M	SD	M	SD	T	*P*	LL	UL
1	Age	24.06	5.52	14.07	5.5.2	0.077	0.94	−0.52	0.55
2	Gender	Women (*N* = 1.819)	Men (*N* = 699)	Women (*N* = 290)	Men (*N* = 95)				
3	Duration of study	7.09	4.80	7.04	4.98	−0.20	0.84	−0.58	0.47
4	TP	3.33	1.04	3.39	1.04	1.25	0.21	−0.04	0.18
5	EX	2.75	1.63	2.68	1.54	−0.78	0.43	−0.24	0.10
6	HLP	2.22	1,22	2.17	1.19	−0.71	0.48	−0.17	0.08

TP, time pressure; EX, exhaustion (MBI); HLP, health-related loss of productivity; T1, time 1; T2, time 2; T3, time 3.

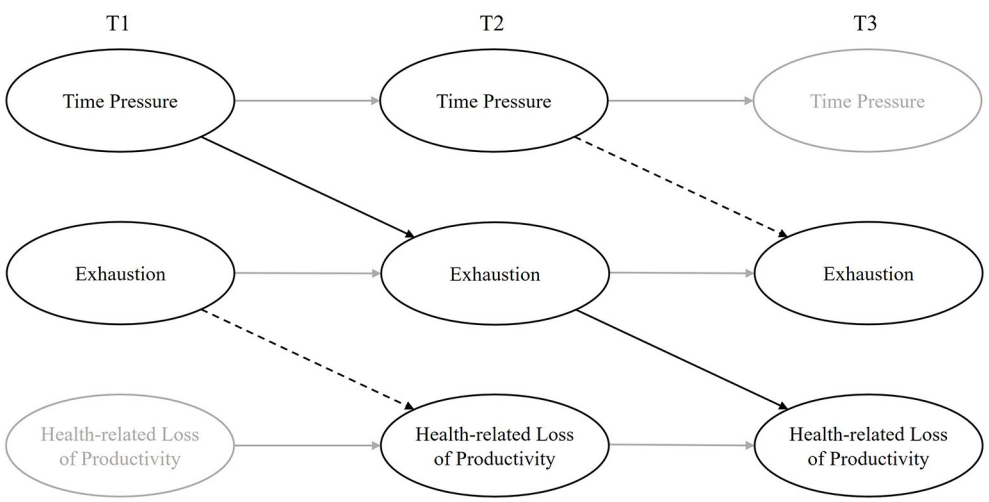

FIGURE 2 | The hypothesized model. All exogenous latent constructs are represented by manifest variables shown in **Table 2**.

three measurement points (36). The model fitted the data significantly better than the unrestricted model. The standardized loadings of the measurement-time-specific indicators were <0.40 and can be classified as low to moderate. We can therefore assume configural measurement invariance for all three study variables over time.

Structural Equation Model

In a second step we tested the model which only includes the autoregressive effects of each latent variable over time (time pressure, exhaustion, and health-related loss of productivity; M0). This model also showed an acceptable fit (χ^2 (459) = 1,194.954, $p < 0.01$; RMSEA = 0.06; SRMR = 0.08; TLI = 0.93;

TABLE 2 | Means, standard deviations, correlations and Cronbachs Alpha of the latent variables.

		M	SD	1	2	3	4	5	6	7	8	9
1	TP T1	4.65	1.12	(0.83)								
2	TP T2	4.69	1.13	0.69	(0.87)							
3	TP T3	4.59	1.12	0.63	0.72	(0.88)						
4	EX T1	2.68	1.54	0.52	0.47	0.45	(0.80)					
5	EX T2	2.62	1.70	0.48	0.60	0.53	0.74	(0.84)				
6	EX T3	2.63	1.67	0.48	0.52	0.60	0.69	0.73	(0.94)			
7	HLP T1	2.12	1.19	0.36	0.33	0.30	0.50	0.46	0.45	(0.96)		
8	HLP T2	2.12	1.19	0.19	0.27	0.27	0.48	0.48	0.45	0.58	(0.96)	
9	HLP T3	2.20	1.27	0.22	0.20	0.30	0.40	0.39	0.48	0.49	0.51	(0.96)

TP, Time Pressure; EX, exhaustion (MBI); HLP, Health-related Loss of Productivity; Cronbachs Alpha in parenthesis; T1, time 1; T2, time 2; T3, time 3.

CFI = 0.93; AIC = 35,585.22). Exhaustion ($0.84 \leq \beta \leq 0.91$) and time pressure ($\beta = 0.86$) were more stable than health-related loss of productivity ($0.56 \leq \beta \leq 0.64$).

Then we added the paths as mentioned above (M1; see **Figure 2**). The final model is depicted in **Figure 3**. The final model showed an acceptable fit (χ^2 (459) = 1,141.36, $p < 0.01$; RMSEA = 0.06; SRMR = 0.06; TLI = 0.93; CFI = 0.93; AIC = 35,534.04). Comparing the AIC of the competing models (M0, M1), the final model (M1) showed a better fit. The autoregressive effects are slightly smaller compared to M0.

Hypothesis 1 postulated that time pressure leads to student burnout over time. Indeed, time pressure at T1 significantly predicted exhaustion at T2 ($\beta = 0.13$; $p < 0.05$). Furthermore, time pressure at T2 significantly predicted exhaustion at T3 ($\beta = 0.13$; $p < 0.05$). These results support Hypothesis 1.

Hypothesis 2 postulated that student burnout leads to health-related loss of productivity over time. As we can see, exhaustion at T1 significantly predicted health-related loss of productivity at T2 ($\beta = 0.24$; $p < 0.001$), and exhaustion at T2 significantly predicted health-related loss of productivity at T3 ($\beta = 0.28$; $p < 0.001$), which supports Hypothesis 2.

Hypothesis 3 postulated that student burnout (T2) mediates the longitudinal effect from time pressure (T1) on health-related loss of productivity (T3). To test this hypothesis, we added a direct path from time pressure (T1) to health-related loss of productivity (T3). Since this model fitted the data worse (χ^2 (459) = 1,141.44, $p < 0.01$; RMSEA = 0.06; SRMR = 0.06; TLI = 0.93; CFI = 0.93) and the AIC increased (AIC = 35,535.70), we can assume that exhaustion fully mediates the effect from time pressure (T1) to health-related loss of productivity (T3). This approach is in line with the requirements for mediation models postulated by Dormann et al. (35). The bias-corrected bootstrap interval for the indirect effect from time pressure (T1) on health-related loss of productivity (T3) (CI 95% 0.01–0.12) indicates a significant indirect effect from time pressure (T1) to health-related loss of productivity (T3).

After testing M1, we tested the model with reversed causal effects (M2). The AIC for this model was worse compared with M1 (AIC = 35,576.13), the relevant longitudinal path from health-related loss of productivity (T1) on exhaustion (T2) was small and non-significant ($\beta = -0.07$; $p > 0.05$). Also, the longitudinal path from exhaustion (T2) on time pressure (T3) was small and non-significant ($\beta = 0.07$; $p > 0.05$). However, only the longitudinal effect from exhaustion (T1) to time pressure (T2) was significant ($\beta = 0.13$; $p < 0.05$) (see **Supplementary Material**).

Finally, we tested the model with reciprocal causal effects (M3). The AIC for this model was slightly better than for M1 (AIC = 35,529.475). However, only two longitudinal paths in this model were significant: the path from exhaustion (T1) on health-related loss of productivity (T2; $\beta = 0.23$; $p < 0.001$) and from exhaustion (T2) on health-related loss of productivity (T3; $\beta = 0.27$; $p < 0.001$) (see **Supplementary Material**). Only in M1 all longitudinal paths could be statistically validated. Since this was not the case for either the reversed model (M2) nor the reciprocal model (M3), we decided to retain M1.

DISCUSSION

Our study examined how time pressure, student burnout and health (health-related loss of productivity) are related over time. We adopted a three-wave panel design to establish a better understanding of the antecedents of health-related productivity loss. As hypothesized, time pressure leads to exhaustion, and exhaustion leads to health-related productivity loss over time. Hence—as assumed by the SD-R's health impairment process—burnout serves as a mediator between time pressure and the health-related loss of productivity.

In line with our predictions, time pressure showed to be positively related to a change in exhaustion, and exhaustion showed to be predictive for changes in health-related loss of productivity within a time-interval of 6 months. Adachi and Willoughby (37) claim that regression coefficients in longitudinal research are often much smaller than those in cross-sectional research. The authors argue that even smaller longitudinal regression coefficients are substantial, especially if the autoregressive effects are large (37). Furthermore, the longitudinal regression coefficients we found in our study are comparable to those reported in other longitudinal studies on student well-being [e.g., (38, 39)].

There is a controversial discussion about where to situate health-related loss of productivity within the SD-R framework.

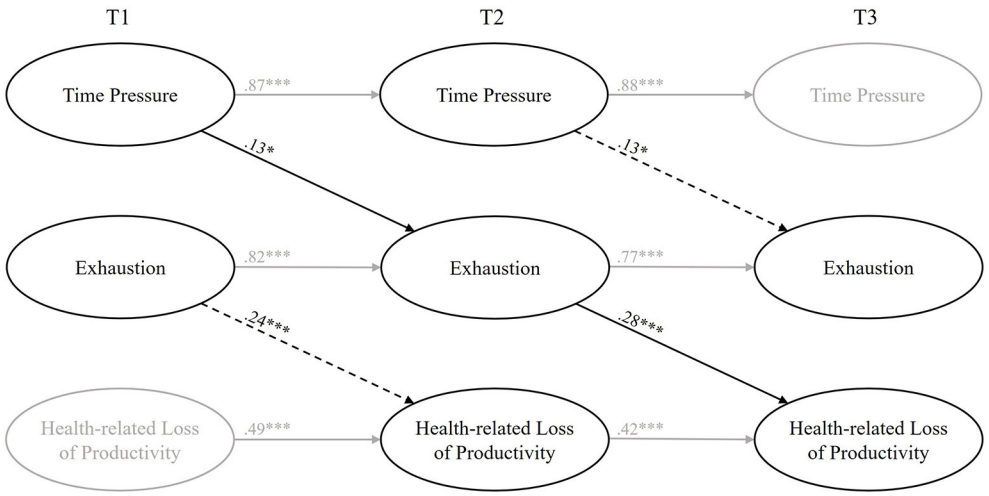

FIGURE 3 | The final model. The manifest variables are not shown in this figure. *$p > 0.05$; **$p > 0.01$; ***$p > 0.001$.

To our knowledge, two other studies have examined the relationship between (job) demands, burnout, and health-related productivity loss. In line with our perspective, McGregor et al. (6) considered health-related productivity loss as an outcome in the SD-R framework. However, due to the lack of longitudinal data, the authors were not able to test their assumptions properly. In contrast, Demerouti et al. (1) considered presenteeism to be a behavioral pattern that leads to burnout. In their three-wave study, they showed that (job) demands (T1-T2) significantly predicted exhaustion and presenteeism (only T2-T3) in the long run. Furthermore, exhaustion predicted presenteeism (T1-T2) and (job) demands (T1-T2), but they did not analyze any possible mediating effects of exhaustion (1).

When we only consider the lagged effect from time pressure on exhaustion, our results are in line with those of Demerouti et al. (1). As in their study, we have verified a lagged effect from time pressure on exhaustion. However, a lagged effect from exhaustion (T1-T2) on time pressure (T2-T3) is not consistent with our data. We could also show the lagged effect from exhaustion on health-related loss of productivity for both time intervals. This confirms the idea of loss spirals suggested by Hobfoll (40), in that exhaustion leads to reduced productivity, and underlines the necessity to recover after intense studying. However, reciprocal effects between both constructs are also conceivable since health-related loss of productivity in turn may increase exhaustion, although Demerouti et al. (1) found this effect for only one interval (T2-T3). Therefore, we tested the reciprocal relationships (M3) between health-related productivity loss (T1-T2) and exhaustion (T2-T3) and found that these paths were not significant for either interval.

STRENGTHS AND LIMITATIONS

Our study is among the first that examines health-related (burnout) and non-health related (time pressure) causes of health-related loss of productivity as assumed by SD-R's health impairment process. Nevertheless, there are some issues we have to address below.

First, all variables were measured with self-reports, which might cause biases due to common method variance. However, we measured the variables with well-established and evaluated instruments. Demerouti et al. (1) operationalized their (job) demands more heterogeneously (workload, patient demands, physical demands), while McGregor et al. (6) used the Burgen Bullying Index. We focused solely on time pressure, a major predictor in burnout research. McGregor et al. (6) measured health-related loss of productivity with only one item (the total number of days lost at work due to presenteeism in the past year), whereas Demerouti et al. (1) directly asked whether participants had gone to work despite feeling sick in the past year. In contrast to them, we used the Stanford Presenteeism Scale, a well-established instrument that measures health-related loss of productivity with several items.

Second, even though CLPM is the most appropriate method for mediation analyses, it tends to overestimate the stability (autoregressive effects) of constructs and to underestimate the cross-lagged effects (41). Following this argument, the presented paths for example, from time pressure (T1) to exhaustion (T2) and from exhaustion (T2) to health-related loss of productivity (T3) might be larger than those shown in our analysis.

Third, lagged effects and fit indices of longitudinal models can change tremendously depending on the chosen time lag between the occasions. If the time lag between the occasions is too short, possible existing effects may not be detected. If the time lag between the occasions is too long, the effect may be underestimated (42). In studies regarding the consequences of health-related sickness presenteeism on health and well-being, the time lag was 2 to 12 months (43). As we know from our analysis, the stability of time pressure and exhaustion were very high, implying that any effects would need time to unfold. Therefore, we chose 6 months given that it is the

most common time lag for longitudinal studies in organizational psychology (44).

Fourth, longitudinal studies inevitably suffer from non-response and attrition. The smaller database may bias the results and limit its generalizability. At the first occasion, we surveyed 3,420 students, at the second occasion 866 and at the last occasion 392. However, in order to examine whether the willingness to repeat was influenced by study variables, we compared participants who took part only at the first occasion with those who participated at T2 and T3 using *t*-tests. We did not find any significant differences between the participants, neither in the study variables nor in demographics (age, gender, workload).

Finally, our study was carried out at only one German university. It was not designed to examine differences between students from different universities and cultures, which would have required larger sample sizes. However, since the study conditions in Europe have been standardized due to the Bologna process, our results should also be relevant for other universities.

CONCLUSION AND FUTURE RESEARCH

To our knowledge, our study is among the first that examined the relationship between time pressure and health-related loss of productivity mediated by exhaustion. There is a need for studies on health-related and non-health related causes of health-related productivity loss since these antecedents remain poorly understood and have rarely been investigated in university students. Our study further confirms SD-R's health impairment process longitudinally. The SD-R framework serves as an excellent theoretical basis to assess pathogenic effects of the study context on students' health and well-being. Specifically, we now know that time pressure constitutes one of the major demands at universities, leading to student burnout and impaired health in the long run. Therefore, we propose to implement interventions that address the pathogenic process in three dimensions:

First, study demands and especially time pressure due to an unequal distribution of workload need to be revisited (45, 46). Manageable workload has a positive effect on students' motivation and interest (47). However, there are almost no interventions that explicitly address time pressure for students by modifying study programs or structural settings at university. This is a large research gap that needs to be closed. We strongly advocate for an improvement of interventions on time pressure to prevent the negative consequences on students' health and well-being. Future research needs to focus on the conception and implementation of these interventions.

Second, students' time management should be ameliorated via time management training that helps students deal with time pressure. Whereas the first approach is directed toward the magnitude of demands, this approach intends to strengthen students' coping skills when dealing with time pressure. Time management training as an intervention has already been installed in educational settings (48), but is still not implemented as a regular offer for college students. Time management training is a promising tool to decrease perceived stress and increase perceived time control in university students (49).

Third, students' personal and interpersonal resources should be reinforced. Interpersonal resources such as supervisor support play a crucial role for preventing burnout (50). For university students, teacher support may be even more important than social support by for example, friends (51). Personal resources such as resilience also play a crucial role in students' health and well-being. Resilience training has positive effects on physicians (52), especially when combined with other intervention elements (53). So far, however, studies on the effects of resilience trainings at university have focused mainly on medical students (54, 55). Evidence for the general student population are missing.

Further research is needed to evaluate these approaches. In our view, interventions should address both, behavioral and structural changes in university (students). Since time pressure serves as the major study demand, we also propose regularly monitoring time pressure in students to prevent health-related productivity losses.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics committee Freie Universität Berlin; FB Erziehungswissenschaft Psychologie. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

BG, TL, and CW: conceptualization, methodology, investigation, writing—review and editing, and project administration. BG and TL: validation, data curation, writing—original draft preparation, and visualization. BG: formal analysis and supervision. All authors: contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.653440/full#supplementary-material

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Health Related Studyability-An Approach to Structure Health Promotion Interventions at Universities

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So far, the only existing prerequisite to enter an academic institution is a specific diploma, like a high school diploma, or another comparable certified document. Other requirements may only be a numerus clausus for certain fields of study to pave the bureaucratic way for a prospective student into their university life. The way first year students dive into their first academic experiences is entirely left to themselves. (Soft) Skills and Competences that exceed the expertise of the chosen courses but are essential for this new, and very challenging, chapter of their lives are not taught to them. Therefore, student health promotion for young adults is essential to build and sustain a healthy lifestyle during their academic careers. Nevertheless, it is important to consider not only a student's perspective but also structural and organizational conditions within the academic institutions. The further development of Ilmarinen's concept of workability may help to construct a theoretical and empirically based concept to implement health-promoting conditions for a student health promotion system at universities. Ilmarinen's concept was chosen by the work group in terms of the structure, which may be adapted to a university since it can be seen as a student's workplace.

Keywords: studyability, workability, health-related studies, university health promotion, health management

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INTRODUCTION

Student health promotion takes on various tasks. On the one hand, those responsible should ensure that students are and remain in good physical and mental health during their studies. On the other hand, health skills for the professional future are to be taught in order to demonstrate a healthy lifestyle to the target group. The main goal is to reach a health-related studyability – the ability to complete a degree in a physically and mentally healthy manner. Prospectively, this may prepare the workability for the future career.

Current surveys show that even within this rather young and healthy population there may be vulnerable groups who are at risk of serious health consequences. Empirical studies on students in Germany show that we talk about manifold health risks concerning these groups:

- Recurrent (min. once a week) physical complaints like back and neck pain and body aches (1, 2).
- A high occurrence of depressive symptoms, compared to the normal population (1, 3).
- An increased negative experience of stress (3).

- ¾ of the target group do not reach the recommendations for physical activity given by the World Health Organization (WHO) (1).
- An increased prescription of antihypertensive and antithrombotic drugs (2).

Analyses show that the population is highly prone to progressive metabolic, orthopedic, and mental health risks. In accordance with the approach of primary prevention and health promotion it is essential to intervene at this point in order to halt this negative development.

Even students who are meant to be healthy for the moment are exposed to these risk factors. Primary preventive action must be taken at this point to ensure that the health status of these young people does not deteriorate dramatically resulting in distal effects later in their working lives.

However, health promotion interventions should not only focus on the behavior of the students. At the same time, it must be determined which conditions at universities have to be addressed to enable healthy studies. For this purpose, an already existing model from workplace health management is to be adapted and enhanced to the students' needs and the university setting. The model ultimately serves as a heuristic, and to identify but also to develop and evaluate measures for areas of action in primary prevention. Moreover, it may be used to adapt the overall structures and conditions.

HOUSE OF WORKABILITY

The house of workability is a theoretical concept to determine the resources and the needs of employees in a multifunctional context. This model was developed on the basis of empirical findings related to the workability index (WAI) by a work group of the Finnish Institute for Occupational Health (FIOH) around Juhani Ilmarinen (4). "Work ability can be defined as the balance between human resources and the demands of work" (5). This ability is based on various factors, which are influenced not only by the employee but also by the employer/company (4, 6).

The WAI is a construct from the point of view of occupational health. It is used as a predictor for any kind of inability to work, such as sickness absences or early retirements. Thus, it is a well-established assessment tool, which is often used in the workplace setting.

The underlying theoretical model, the house of workability, pursues a less deficit-oriented goal and tries to represent those resources, which are the basics of workability, in a house with several floors. The focus of the model is substantiating the resources and support options to maintain workability.

The configuration of each floor may develop and improve the workability, which is influenced by the following factors (5, 7):

- Ground floor: health and functional capacities: physical, mental and social health, and efficiency in relation to work.
- 1st floor: competences, experiences, learning: technical, methodical, and socially supportive measures to cope with the work tasks.
- 2nd floor: values, attitudes, and motivation: appreciation and fair treatment by the superior, trust in the superior, commitment, and motivation for work.
- 3rd floor: work, work arrangements, work community, leadership: organization of work, support from superiors and colleagues in difficult situations, feedback from superiors.

TRANSFORMATION INTO THE HOUSE OF STUDYABILITY

The original model is perfectly suited to transform it into the house of studyability in terms of the technical and structural requirements and complement it with health-related competences, values, motivation, and structural organization (8). In the end, a concept is being created which is structurally based on the house of workability, but defined through more flexible design criteria that comprise the requirements of an academic institution.

The fact that one's studyability is influenced by multidimensional aspects is important to be acknowledged in the field of student health promotion. Therefore, it is to be underlined, that any intervention concerning health promotion must not only concentrate on the student's behavior, but also on structural, technical, and organizational factors and the working conditions within the academic institution.

The factors functional capacities, competences, values, attitudes and motivation, work community, and leadership are consistent with the original model. Just like the house of workability the house of studyability will distribute that multiple factors influence the accomplishment of the given tasks and need to be seen in a complex interaction.

Since the working conditions, the complex daily tasks, and the functions and hierarchies differ very much in between universities, and even within universities and their faculties, the main focus lies on the adaption of every single floor to the university system in general. Further, adjustments may need to be made for each university referring to some organizational and structural conditions.

FORMER EXPERIENCE AND FUTURE VISION OF THE PROJECT

The department prevention and rehabilitation of the Sports Institute of Heidelberg University has been dealing with the issues of a functional workplace health promotion and its requirements for more than 25 years. The work group was able to give support to several projects and initiatives in a wide variety of industries. Such as highly qualified manufacturing areas in the automotive industry, universities, public service administrations, branches with a high level of physical activity, and small- and medium-sized businesses.

Adding the current research results to this experience, the work group was able to identify conditions and criteria which are decisive as quality standards to establish a successful workplace health management. Therefore, these quality standards are taken

into account during the process of the development of the house of studyability.

These are the quality standards mentioned above:

- A situation and needs analysis on a regular basis.
- Any activities and actions will be initiated based on the identified needs.
- A suitable and well-established organization and process structure.
- Activities and interventions take place right at the workplace.
- Development and improvement of self-efficacy and health literacy.
- Evaluation and success control on a regular basis.

These criteria not only stand for a way to success but also for the opportunity to act sustainably.

Since requirements and situations in the social life tend to develop dynamically those quality standards and the strategic approach to move forward should be adapted consecutively. Transferring the ground works of health promotion to academic institutions is obvious since the social potential of the future is formed and shaped in these institutions. Students of today may become the leaders of tomorrow and therefore take on responsibilities for their employees in the future. In this ever-changing world health promotion is an incredibly important topic, which should be internalized as early as possible.

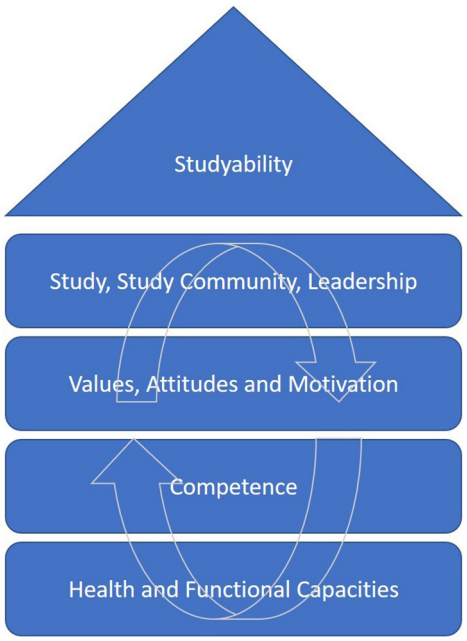

FIGURE 1 | The house of studyability displays the interaction between the factors [adapted from (5)].

DISCUSSION AND OUTLOOK

Model constructs such as the house of studyability can be used as an orientation in the development of processes and sustainable structures. In the further process, the individual floors of the house of workability will be transferred to the university structures, their functionality will be checked and, if necessary, adapted. For this purpose, we work closely in exchange with the sports institutes of the University of Tübingen and the KIT Karlsruhe and review our results over and over in a critical discussion. In exchange with the working group of the German Network Health Promoting Universities, which is working on a reflection and development tool for the expansion of the health management at universities, further, components of the house of studyability will be added.

The foundation to "furnish" the house has been laid: there are already numerous studies in Germany on the psychosocial health and physical and mental health behavior of students. Instruments for collecting these data are available and are currently being widely used in order to generate a large quantity of data that allows a statement to be made concerning the health situation of students.

However, if one ascends to the higher floors of the building, the data situation becomes thinner. Hardly any survey addresses the competences of students, focuses on the motivation and values that stand between students and those responsible at the university, or questions the organization of work, which has a significant influence on everyday study life. All these factors, however, make a significant contribution to whether a student feels healthy - or not.

Nevertheless, national and international surveys determine a certain vulnerability of the group of students. As described earlier, many students already suffer from physical as well as mental disorders - others pave the way for later developing serious chronic diseases by sitting too long and by being physically inactive. However, studying healthy does not only mean being free of physical and mental illness at the time of studying. Feeling healthy while studying also means, above all, feeling good while studying. In line with Ilmarinen's view, this includes above all the awareness that the construct of (health-related) study ability is multidimensional. There is much more to a healthy study than physical and mental integrity. In this case, the universally recognized WHO definition of health from 1946 should be cited again: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (9). The well-being mentioned in the WHO's definition of health is one of the most important things to aim for. A successful interaction between the health-related factors of the house of studyability (as in the floors of the house) paves the way to reach this aim. Without physical, mental, and social health, the factors of values, motivation and organization cannot be developed, even so, a flawed health-related value system or health-promoting working conditions imply that the functional capacities cannot be achieved. **Figure 1** depicts the structural model and the interactions between the factors.

In the following work process, the data situation on the floors of the house of studyability is reviewed. With the involvement of the German Network Health Promoting Universities, the analysis can be extended to other universities. The analysis includes a research and review of previous empirically collected data in the following sub-areas of the studyability concept:

1. Competences, experience, learning: professional, methodical, and social supportive measures to cope with the tasks in the studies, such as writing homework, compiling a good timetable, observing the standard period of study, etc.,
2. Values, attitudes, and motivation: appreciation and fair treatment by lecturers, trust in lecturers, commitment, and motivation for studies.
3. Study, study community, and leadership: organization of studies, support by lecturers and fellow students in difficult situations, feedback from lecturers/teachers/examiners/administrators on administrative procedures (e.g., exam registration, grade entry).

Within this process, the house of studyability will be filled with data as well as instruments for the investigation of the mentioned topics. A systematization of the mentioned sub-areas is aimed at. The structure of the model is intended to ensure control of the application-oriented conception and implementation of interventions.

The result is a model that can be applied across institutions to develop a student health management at universities. The use of the future model structures can immediately be seen as a criterion for quality management.

The vision lies in the function of the model as:

- Heuristic model to classify already existing programs and measures at universities and thus identify missing structures and interventions.
- Instrument for the detection and identification of vulnerable groups (high risk exposure, low self-help), and/or need for change in organizational structures.
- Methodical manual for the structured development of a student health management system.
- Communication basis for scientific findings and the effectiveness of measures between health professionals and university management positions.

The aim is to ensure transfer of the measures and results to other sites and to ensure sustainable use with potential for generating added value for the establishment, implementation, and maintenance of a student health management at universities. With this model the appeal of the Okanagan Charter is being addressed. It intends to imply health promotion in universities with respect to the stated targets of the charter (10).

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

MK, JG, and KW wrote the manuscript. MK, JG, KW, and GH are working on the presented model. GH was the group leader of the project group. All authors contributed to the article and approved the submitted version.

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Effects of a Brief Web-Based "Social Norms"-Intervention on Alcohol, Tobacco and Cannabis Use Among German University Students: Results of a Cluster-Controlled Trial Conducted at Eight Universities

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Background and Aim: "Social norms" (SN)-interventions are aimed at changing existing misperceptions regarding peer substance use by providing feedback on actual norms, thereby affecting personal substance use. It is unknown whether SN-intervention effects previously demonstrated in US students can be replicated in German students. The aim of the INSIST-study was to examine the effects of a web-based SN-intervention on substance use.

Design: Cluster-controlled trial.

Setting: Eight Universities in Germany.

Participants and Measurements: Students were recruited at four intervention vs. four delayed intervention control Universities. 4,463 students completed baseline, 1,255 students (59% female) completed both baseline and 5-months follow-up web-based surveys on personal and perceived peer substance use. Intervention participants received feedback contrasting personal and perceived peer use with previously assessed use and perceptions of same-sex, same-university peers. Intervention effects were assessed *via* multivariable mixed logistic regression models.

Findings: Relative to controls, reception of SN-feedback was associated with higher odds for decreased alcohol use (OR: 1.91, 95% CI 1.42-2.56). This effect was most pronounced in students overestimating peer use at baseline and under or

accurately estimating it at follow-up (OR: 6.28, 95% CI 2.00-19.8). The OR was 1.33 (95% CI 0.67-2.65) for decreased cannabis use in students at intervention Universities and was statistically significant at 1.70 (95% CI 1.13-2.55) when contrasting unchanged and decreased with increased use. Regarding tobacco use and episodes of drunkenness, no intervention effects were found.

Conclusions: This study was the first cluster-controlled trial suggesting beneficial effects of web-based SN-intervention on alcohol and cannabis use in a large sample of German University students.

Clinical Trial Registration: The trial registration number of the INSIST-study is DRKS00007635 at the "German Clinical Trials Register."

Keywords: "social norms"-intervention, University context, cluster-controlled trial, substance use, alcohol, cannabis

INTRODUCTION

It has previously been argued that the University setting is a high-risk environment for substance use due to the opportunity to use (1). Wicki and colleagues (2) reviewed the role of the University environment and student characteristics with regard to alcohol use at European campuses, including results of 65 studies. They found that alcohol was mainly consumed during social gatherings and that social motives for drinking were important. Alcohol and the use of other substances is perceived to be part of students' life and personally engaging in it is perceived to be adequate behavior to match the norm of peer behavior and to maintain conformity with the peer group (3). Harmful substance use behavior is prevalent among German University students. In a survey among students of 16 Universities in the German federal state of North Rhine-Westphalia, 80% reporting heavy drinking (4). Forty percent of the surveyed students had smoked (15% former, and 23% current smokers). Moreover, 41% of students had used cannabis at least once in their lifetime (5).

International research suggests that University students tend to overestimate both the perceived quantity (*descriptive norm*) (6–8) and perceived acceptability (*injunctive norm*) (9) of alcohol and other substances used by their peers. Inaccurate perceptions can cause the individual to increase personal use in an attempt to match the personal behavior to the perceived peer norm. Overestimations of peer licit (6–8) and illicit substance use (10–12) and associations with increased personal substance use among University students have been demonstrated in US and European studies (8, 10, 13).

Social norms (SN)-interventions involve personalized normative feedback (PNF) contrasting personal norms or perceptions of substance use and attitudes toward use among peers with data on actual use and attitudes in the peer group (14–16). Data on perceived attitudes and use, as well as actual attitudes and use, are assessed prior to the development of the feedback (15). PNF is then typically composed of three main components: (a) a student's self-reported own frequency of substance use, (b) a student's perceptions of substance use in the peer group, (c) actual frequencies of substance use in the peer group (17). Findings of SN-intervention studies suggest that participation in PNF leads to a reduction of social pressure on the individual and may consequently reduce personal substance use (18, 19). Recent studies have attempted to further unravel the effects of individual intervention components of SN-interventions and to identify optimal combinations of components. For example, one study examined the added benefit of an intervention combining descriptive-norms-feedback with injunctive-norms-feedback compared to a descriptive-norms-feedback only intervention. The study found that the combined intervention did not predict less drinking 2 weeks post-intervention compared to the single-component intervention (20). Another study investigated whether a full PNF compared to only providing the social comparison information to heavy drinkers was of similar effectiveness in reducing alcohol use. Results suggested that information regarding the discrepancy between actual drinking and the perceived drinking norm (i.e., "most students do not drink as much as you think they do") did not have to be provided to reduce normative misperceptions (17).

There is already evidence regarding the effects of full PNF and various components and modalities of PNF on alcohol use in middle-aged adults (21) and students enrolled in the North-American college system (19). Specifically, the meta-analysis of 19 randomized controlled trials, including 8,095 adults, conducted by Riper et al. (21) revealed that individuals participating in internet-based interventions for adult problem drinking displayed a greater mean decrease in standard units of alcohol consumed per week at follow-up (compared to controls). Interventions based on PNF alone appeared to be less effective in promoting maintenance of low-risk drinking behavior compared to internet-based interventions based on therapeutic principles. Neighbors et al. (19) examined the efficacy of gender-specific vs. gender-nonspecific PNF in 818 heavy-drinking freshmen in a randomized controlled trial over the course of 2 years. They found that compared to controls, gender-specific biannual PNF was associated with reduced weekly drinking which was partially mediated by perceived norms that had changed over time.

Abbreviations: SN, social norms; PNF, personalized normative feedback.

Despite a growing body of evidence coming from EU-based studies examining the effects of SN-interventions, relatively little continues to be known about the effects of PNF in students enrolled at European Universities since the publication of the article of (3). Particularly in Germany, the effects of PNF on substance use continue to not be well-understood.

Furthermore, we assume that results of US studies on the effects of SN-interventions cannot simply be generalized to the European University environment. Comparisons between Germany and the US in the general population reveal differences between both countries in substance use prevalence which form the basis of normative feedback [Germany: larger percentage of respondents reporting current drinking and heavy drinking, US: respondents reported more alcohol-related problems at matched alcohol volume levels (22)]. A comparison between Sweden and the US suggests that, despite a higher alcohol use prevalence in Sweden, research from the US is generalizable to Swedish students and vice versa due to similar patterns between etiological predictors and outcomes (23). It is, however, doubtful whether this generalization can be extended to the German student population. One major difference that has an impact on the perception of use is certainly that, in Germany, only about 10% of German students live on campus and the majority of students live off-campus (24). Furthermore, the minimum legal drinking age differs between countries (21 vs. 18) and the regulations and policies at Universities vary between countries. Hence, social norms regarding substance use may be shaped less by substance use behavior visible in the proximal vicinity of students (i.e., on-campus) but probably more during off-campus activities (e.g., nightlife, private parties). Furthermore, the drinking occasions differ between countries. For instance, normative feedback interventions from the US focus on drinking at 21st birthday events known as dangerous drinking traditions that shape drinking behavior there (25), but the 21st birthday is not particularly celebrated in Germany.

A systematic review by Berman et al. (26) recently examined the effects of mobile interventions on risky drinking among University students (compared to controls) and included seven studies examining the effects of interventions employing varying modalities (text messages: $n = 4$, interactive voice response: $n = 1$, smartphone apps: $n = 2$). This review included one study conducted in Sweden by Andersson [(27), $n = 1.678$] examining the effects of different modalities of PNF (and protective behavioral strategies) on peak blood alcohol concentrations. Compared to controls, both the interactive voice response (IVR)- and the internet-based interventions led to a small but significant overall reduction in peak blood alcohol concentrations at the 6-week follow-up. A Swiss study investigated the long-term efficacy of an internet-based brief intervention, including normative and personalized feedback, for decreasing alcohol use among men assessing the number of drinks consumed per week and the occasions that men engaged in binge drinking (28). They found no differences between the intervention and control group regarding the number of drinks consumed per week and the prevalence of binge drinking at follow-up. The "Social Norms Intervention for the prevention of Polydrug usE" (SNIPE)-study was the first multi-national European study demonstrating the feasibility of this type of intervention on alcohol, tobacco, and illicit drugs in seven European countries (29) and demonstrating misperceptions regarding various substances [e.g., (10, 30)]. However, intervention effects were not evaluated in this study. Therefore, we conducted the INSIST ("INternet-based Social norms-Intervention for the prevention of substance use among Students")-study to investigate intervention effects of the previously developed SN-intervention on misperceived social norms and the frequency of licit and illicit substance use among German University students enrolled at four intervention Universities compared to students enrolled at four delayed intervention control Universities (31).

The research questions were (a) whether students participating in the intervention reported lower rates of licit and illicit substance use (i.e., alcohol, tobacco, and cannabis consumption, episodes of drunkenness) at follow-up than those not participating in the intervention and (b) whether misperceptions of peer substance use were reduced as a consequence of participating in the intervention.

METHODS

Participants and Procedures

Ethical approval was obtained from institutional review boards of all participating Universities. Data protection was monitored by the local data protection agency in the city state of Bremen. Eight Universities in four regions participated in the study (Hamburg University of Applied Sciences, Hannover Medical School, University of Bielefeld, Heinrich Heine University Duesseldorf, Martin-Luther-University Halle-Wittenberg, Technical University Dresden, Heidelberg University, Mannheim University). In each region, one University served as intervention, one as comparison site. Within a geographical area, intervention and control Universities were determined by random selection. Intervention and control Universities in each of the four regions were located in different cities (*intervention sites:* Hamburg, Bielefeld, Heidelberg, Halle vs. *control sites:* Hannover, Duesseldorf, Mannheim, Dresden). We had no consistent information on usual substance use prevalence at the included Universities, hence the only comparative data we have result from the current study.

Recruitment for the study started in January 2014 (31). In the study, we had one overarching recruitment strategy across the participating Universities. At each University, one local student was part of the study staff and in charge of recruitment *via* email, the Universities' websites, intranet, or student e-learning platforms. Additional public recruitment channels included local newspaper articles, local radiobroadcasts, and student newsletters. Moreover, students were personally invited to participate in the study in seminars by University staff. Further, print-materials were used to recruit students as well as social media channels of Universities (i.e., Facebook). Students were included in the study if they were enrolled at one of the participating Universities, were aged 18 years and older, had

access to the internet and an email-address. After registering onto the website, students received an email containing a hyperlink to the German language survey website where students could enter their email-address and choose their respective University and gender (female, male, or other). This information was then used to create the individualized University- and gender-specific SN-feedback which was delivered during the intervention. Students were also told that they could withdraw from the study at any time. Overall, 167,686 students were enrolled at the participating Universities. 7,088 students (4%) registered on the study website,

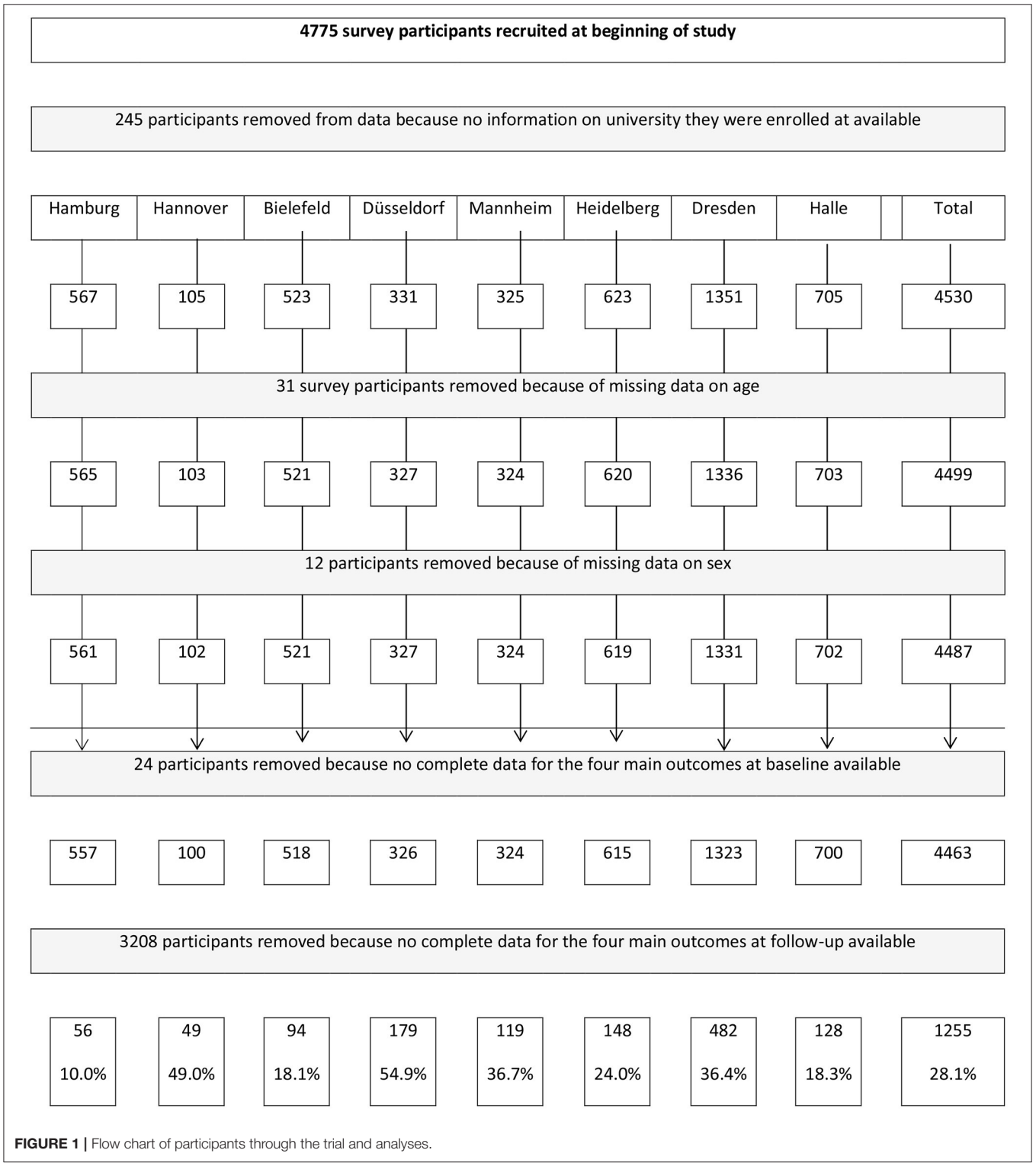

FIGURE 1 | Flow chart of participants through the trial and analyses.

TABLE 1 | Sample characteristics by group and gender at baseline.

	Males		Females		All	
	CG ($n = 372$)	IG ($n = 140$)	CG ($n = 457$)	IG ($n = 286$)	CG ($n = 829$)	IG ($n = 426$)
	N (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)
Age						
≤20 years	77 (20.7)	26 (18.6)	105 (23.0)	59 (20.6)	182 (22.0)	85 (20.0)
21-25 years	206 (55.4)	81 (57.9)	250 (54.7)	157 (54.9)	456 (55.0)	238 (55.9)
26-30 years	69 (18.5)	23 (16.4)	82 (17.9)	57 (19.9)	151 (18.2)	80 (18.8)
≥31+ years	20 (5.4)	10 (7.1)	20 (4.4)	13 (4.5)	40 (4.8)	23 (5.4)
Field of study						
Arts	38 (10.2)	16 (11.4)	73 (16.0)	59 (20.6)	111 (13.4)	75 (17.6)
Business and Law	51 (13.7)	13 (9.3)	37 (8.1)	17 (5.9)	88 (10.6)	30 (7.0)
Engineering	87 (23.4)	10 (7.1)	44 (9.6)	10 (3.5)	131 (15.8)	20 (4.7)
Medicine/Health	52 (14.0)	18 (12.9)	79 (17.3)	68 (23.8)	131 (15.8)	86 (20.2)
Natural Science	57 (15.3)	39 (27.9)	70 (15.3)	47 (16.4)	127 (15.3)	86 (20.2)
Social Sciences	54 (14.5)	23 (16.4)	122 (26.7)	67 (23.4)	176 (21.2)	90 (21.1)
Maths/Informatics	30 (8.1)	16 (11.4)	16 (3.5)	12 (4.2)	46 (5.5)	28 (6.6)
Others	3 (0.8)	5 (3.6)	16 (3.5)	6 (2.1)	19 (2.3)	11 (2.6)
University						
Hamburg		19 (13.6)		37 (12.9)		56 (13.1)
Bielefeld		28 (20.0)		66 (23.1)		94 (22.1)
Heidelberg		61 (43.6)		87 (30.4)		148 (34.7)
Halle		32 (22.9)		96 (33.6)		128 (30.0)
Hannover	18 (4.8)		31 (6.8)		49 (5.9)	
Düsseldorf	72 (19.4)		107 (23.4)		179 (21.6)	
Mannheim	58 (15.6)		61 (13.3)		119 (14.4)	
Dresden	224 (60.2)		258 (56.5)		482 (58.1)	
Residence						
Living with other students	135 (36.3)	40 (28.6)	129 (28.2)	76 (26.6)	264 (31.8)	116 (27.2)

CG, control group; IG, intervention group.

and 4,463 completed the baseline survey (2.7% out of all enrolled students) (see **Figure 1** and **Table 1**).

Web-Based Baseline and Follow-Up Surveys

In the web-based questionnaire, students were asked to answer questions regarding their personal and perceived gender-specific substance use of peers at their University toward using the following substances: Alcoholic beverages, tobacco products, waterpipe, cannabis, non-prescribed medications to improve academic performance, non-prescribed sedatives or sleeping pills, synthetic cannabis, cocaine, ecstasy, other amphetamine-type stimulants, hallucinogens, and inhalants. Furthermore, two types of polydrug use were assessed (i.e., simultaneous use of alcohol and tobacco, of alcohol and illicit substances, such as cannabis, ecstasy, or cocaine). Furthermore, students were asked how often in the last 2 months they drank until they felt drunk. The choice of substances included was based on the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST), developed by the World Health Organization (32) and was slightly adjusted as described in a previous trial (31). Licit and illicit substances were described with a list of examples and, if applicable, trade or street names for each substance. Along with the items on alcohol use, participants were provided with a definition of an alcoholic drink as 0.33 L beer, a small bottle of a ready to drink beverage (0.275L), a small cocktail (0.2L, containing 4cl alcohol), a glass of wine/sparkling wine (0.125L), and a shot of spirits (0.4L).

Referring to this range of substances, students were asked to report their personal substance use. Response options ranged for alcohol (frequency and drank until felt drunk), tobacco, waterpipe, cannabis and polydrug use from "never used in their lives," "used but not in the last 2 months," "used once or twice in the last 2 months," "used every 2 weeks in the last 2 months," "used once or twice in the last week in the last 2 months," "3-4 times per week in the last 2 months," and "daily or almost daily in the last 2 months." The following categories were used for non-prescribed medications and sedatives, synthetic cannabis, cocaine, ecstasy, other amphetamines, hallucinogenic drugs, inhalants: "never used in their lives," "have used but not in the last 2 months," "have used 1-3 times in the last 2 months," "have used weekly or more often in the last 2 months," "have used daily or almost every day in the last 2 months." Furthermore, students were asked to indicate their perceptions

of gender-specific behaviors (*descriptive norm,* the perception of quantity and frequency of substance use in the peer group) among their peers regarding the frequency of alcohol, tobacco, waterpipe, and illicit substance use. To assess the *descriptive norm*, students were asked to imagine all students of their University (100% of the same gender as the respondent) and to estimate the frequency of use of various substances during the last 2 months in their peer group. They were asked to distribute the percentages of students to the same categories for reporting personal use. The questions and the used reference groups followed the same principle of previous SN surveys (29, 33). However, the response modalities differed substantially based upon discussions with the project-own advisory board consisting of international SN researchers (31).

All questions referred to a time period of 2 months prior to assessment. The time frame of the previous 2 months was used as this covered the period when students attended University, as planned in the schedule of data collection. The follow-up survey took place 5 months post-baseline employing the same items. Students at intervention Universities were asked one additional item assessing whether they remembered the content of the normative feedback (including an example). For this article, despite having collected data on prevalences of all the substances listed above, pre-/post-comparisons were only calculated for the three main substances alcohol, tobacco, and cannabis because the prevalence for most of the other substances was too low for comparing use before and after the intervention.

Web-Based SN-Intervention

The intervention developed during the earlier SNIPE-study was further adapted to better fit the German University context based on a focus group discussion with seven students from two Universities in Northern Germany (31). Based on the baseline data on descriptive and injunctive norms related to substance use at the respective University, a gender-specific, normative feedback was developed and sent to students enrolled at the four intervention Universities 8 weeks after completion of the baseline survey. Five months post-baseline (August 2014), students at the delayed intervention control Universities were given access to this feedback. The feedback website consisted of several different main pages that were accessible *via* a navigation menu. Each main page contained information about a different substance (i.e., alcohol, tobacco, cannabis) and was divided into a personalized feedback and a gender- and University-specific feedback. The personalized feedback included the individual information regarding own substance use and the perception of use in the peer group (of the same gender and University) reported by students. If students did not fill out these questions in the baseline questionnaire beforehand, they were informed that an individual feedback could not be given. The gender- and University-specific feedback visualized the perceived peer substance use (of the majority of students of the same gender, same University) estimated by the student. This information was contrasted with the actual substance use pattern of students of the same gender and same University as assessed in the baseline questionnaire. These two comparisons formed the descriptive norms feedback. Furthermore, students received information about the injunctive norms of same-gender peers at their Universities.

Statistical Analysis

Descriptive analysis was performed using tabulations for personal alcohol, tobacco and cannabis use and episodes of drunkenness. Furthermore, we calculated the percentages of respondents who (a) underestimated/accurately estimated peer use both at baseline and at follow-up, (b) overestimated peer use at baseline and underestimated or accurately estimated use at follow-up, (c) underestimated/accurately estimated peer use at baseline and overestimated use at follow-up and, (d) overestimated peer use at both time points regarding alcohol, tobacco, and cannabis. For this, the gender-specific substance use prevalence at the respective University was contrasted with the perception of use of the majority of students of the same gender at the same University. If a student reported "other" gender, the data of all students were used for comparison.

To evaluate intervention efficacy, substance use pre- and post-intervention among students at intervention Universities was compared to the use reported by students enrolled at control Universities. Our main focus was to assess whether consumption of alcohol, tobacco, cannabis and episodes of drunkenness had increased, not changed or decreased from baseline (T0) to follow-up (T1), contrasting intervention and control Universities. Hence, the effect of the intervention on the main outcome (consumption decreased) was assessed by means of multivariable mixed logistic regression models (corrected for clustering at the University level), considering age, gender, as well as baseline substance use, as covariates. Subgroup analyses were conducted to analyse differences in changes in alcohol, cannabis, and tobacco use by gender and by changes in perceptions of peer use over the follow-up. These analyses were stratified by the four groups of peer-use perception combinations. Furthermore, following a similar approach, we used the less stringent criterion "consumption did not increase" (i.e., unchanged or decreased). Odds ratios and 95% confidence intervals were estimated from the models. SAS statistical software (34) was used for all quantitative analyses.

RESULTS

A summary of the sample characteristics can be found in **Table 1** and further details on distinct consumption patterns of concurrent and non-concurrent substance use analyzed with cluster analysis can be found in the article by Schilling et al. (35). A total of six homogeneous groups were identified: "Alcohol Abstainers" (10.8%), "Drinkers Only" (48.2%), "Drinkers and Cigarette Smokers" (14.6%), "Cannabis and Licit Substance Users" (11.2%), "Hookah Users with Co-Use" (9.8%) and "Illicit Substance Users with Co-Use" (5.4%) (35). For this article, the analytic population comprised only students with complete baseline and follow-up information. Intervention participants in the analytic sample ($n = 426$; HAW Hamburg: $n = 56$, University Bielefeld: $n = 94$, University Heidelberg: $n = 148$, MLU Halle: $n =$

128, also see **Table 1**) received feedback contrasting personal and perceived peer use with previously assessed use and perceptions of same-sex, same-University peers. Of those receiving feedback, over one third reported not remembering receiving a normative feedback (HAW Hamburg: 43.1%, University Bielefeld: 34.3%, University Heidelberg: 33.6%, MLU Halle: 27.3%) (not shown). Eight-hundred and twenty-nine participants at the control Universities completed the follow-up survey with most students recruited in Dresden ($n = 482$).

1,255 students (59% female) completed both baseline and follow-up web surveys. At baseline, about 75% were under the age of 25 years. Slightly fewer students at intervention Universities (27.2%) than at control Universities (31.2%) reported living with other students with marked differences between individual sites. The field of study (assessed at baseline) varied broadly, as some Universities were medical schools, others had a strong focus on social sciences or engineering (for further detail, see **Table 1**).

Prevalences for substance use at baseline by group and gender can be found in **Table 2**. Alcohol and tobacco were the substances most commonly used, with markedly higher prevalences among male students and a slightly worse overall profile for control Universities. Use of performance-enhancing drugs, sedatives, and synthetic cannabis was reported very rarely.

With regard to changes in perceptions of peer use, there was a clear pattern of overestimated peer use, both, at baseline and at follow-up, and across all substances. For example, 303 (71.1%) respondents at intervention and 651 (78.5%) respondents at control Universities overestimated alcohol use at both time points. Overall, only 29 persons accurately or under-estimated peer alcohol use at both time points. Only for cannabis use, the picture was somewhat different with 19.1% of controls and 17.4% of intervention participants accurately or under-estimating peer use at both time points (**Table 3**).

Intervention Effects

Regarding alcohol consumption, there were slight differences between the intervention and control groups, as 25.5% in the control group, but 22.8% of the intervention group reported increases from T0 to T1, and 18.3 vs. 28.2% reported decreased consumption (**Table 3**). Regarding decreased consumption, the OR was 1.91 (95% CI 1.42-2.56), and in the small group of students overestimating peer use at baseline and under or accurately estimating peer use at follow-up, the OR was 6.28 (95% CI 2.00-19.8) (**Table 4**). Non-significant findings were obtained when comparing the outcome "alcohol consumption not increased" between intervention and control groups (**Table 5**).

For tobacco use, there were less obvious changes, with 72.1% in the control and 79.3% in the intervention group reporting no change in consumption (**Table 3**). The OR for decreased tobacco consumption between T0 and T1 was 0.68 (95% CI 0.38-1.22) and was not reduced across all categories of peer-use perception (**Table 4**). Combining the unchanged and decreased group into the "not increased" group led to non-significantly elevated OR favoring the intervention across all peer-use perception groups.

13.6% in the control group against 8.0% in the intervention group reported increased cannabis use at follow up, while the unchanged or decreased groups were of very similar size (**Table 3**). The OR was 1.33 (95% CI 0.67-2.65) for decreased consumption in the intervention group (**Table 4**), and was statistically significant at 1.70 (95% CI 1.13-2.55) when contrasting "not increased" vs. "increased" (**Table 5**). Here, the highest OR (11.7) were found in the group that under- or accurately estimated peer use at follow-up and had previously overestimated it (95% CI 1.24-110) (**Table 4**).

TABLE 2 | Baseline prevalence of licit and illicit substance use by group and gender.

	Males		Females		All	
	CG ($n = 372$)	IG ($n = 140$)	CG ($n = 457$)	IG ($n = 286$)	CG (829)	IG ($n = 426$)
	N (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)
Alcohol use						
3x/week or more	98 (26.3)	28 (20.0)	55 (12.0)	30 (10.5)	153 (18.5)	58 (13.6)
Tobacco use						
3x/week or more	49 (13.2)	15 (10.7)	52 (11.4)	31 (10.8)	101 (12.2)	46 (10.8)
Cannabis use						
At least 1x/week	27 (7.3)	8 (5.7)	12 (2.6)	6 (2.1)	39 (4.7)	14 (3.3)
Episodes of drunkenness						
At least 1x/week	58 (15.6)	19 (13.6)	34 (7.4)	20 (7.0)	92 (11.1)	39 (9.2)
Academic performance enhancing drugs						
Use in the past 2 months	4 (1.1)	0 (0)	4 (0.9)	1 (0.3)	8 (1.0)	1 (0.2)
Sedatives/sleeping pills						
Use in the past 2 months	2 (0.5)	1 (0.7)	8 (1.8)	5 (1.7)	10 (1.2)	6 (1.4)
Synthetic cannabis						
Use in the past 2 months	3 (0.8)	1 (0.7)	2 (0.4)	2 (0.7)	5 (0.6)	3 (0.7)

CG, Control group; IG, Intervention group.

TABLE 3 | Change of alcohol, tobacco, cannabis consumption and change in episodes of drunkenness (increased, unchanged, decreased) 5 months post-intervention (stratified by estimation of peer use at T0/T1).

	Stratified by estimation of peer use at baseline (T0) and follow-up (T1)									
	Total analysis group (n = 1,255)		Under-/accurately at T0 Under-/accurately at T1		Overestimated at T0 Under-/accurately at T1		Under-/accurately at T0 Overestimated at T0		Overestimated at T0 Overestimated at T1	
	CG *N* (%)	IG *N* (%)	CG *N* (%)	IG *N* (%)	CG *N* (%)	IG *N* (%)	CG *N* (%)	IG *N* (%)	CG *N* (%)	IG *N* (%)
Alcohol consumption										
Increased	211 (25.5)	97 (22.8)	6 (37.5)	4 (30.8)	7 (15.2)	6 (13.3)	17 (42.5)	3 (17.6)	160 (24.6)	77 (25.4)
Unchanged	466 (56.2)	209 (49.1)	5 (31.3)	6 (46.2)	32 (69.6)	18 (40.0)	14 (35.0)	8 (47.1)	374 (57.5)	147 (48.5)
Decreased	152 (18.3)	120 (28.2)	5 (31.3)	3 (23.1)	7 (15.2)	21 (46.7)	9 (22.5)	6 (35.3)	117 (18.0)	79 (26.1)
Total	829 (100)	426 (100)	16 (100)	13 (100)	46 (100)	45 (100)	40 (100)	17 (100)	651 (100)	303 (100)
Tobacco consumption										
Increased	139 (16.8)	54 (12.7)	5 (12.8)	2 (9.5)	4 (8.0)	3 (7.5)	20 (17.4)	4 (12.5)	93 (17.4)	39 (13.9)
Unchanged	598 (72.1)	338 (79.3)	28 (71.8)	18 (85.7)	39 (78.0)	34 (85.0)	83 (72.2)	26 (81.3)	381 (71.2)	216 (77.1)
Decreased	92 (11.1)	34 (8.0)	6 (15.4)	1 (4.8)	7 (14.0)	3 (7.5)	12 (10.4)	2 (6.3)	61 (11.4)	25 (8.9)
Total	829 (100)	426 (100)	39 (100)	21 (100)	50 (100)	40 (100)	115 (100)	32 (100)	535 (100)	280 (100)
Cannabis consumption										
Increased	113 (13.6)	34 (8.0)	23 (14.5)	2 (2.7)	13 (17.6)	6 (11.8)	12 (14.8)	1 (5.0)	50 (12.2)	16 (7.3)
Unchanged	647 (78.0)	353 (82.9)	118 (74.2)	66 (89.2)	59 (79.7)	38 (74.5)	66 (81.5)	17 (85.0)	325 (79.3)	183 (83.6)
Decreased	69 (8.3)	39 (9.2)	18 (11.3)	6 (8.1)	2 (2.7)	7 (13.7)	3 (3.7)	2 (10.0)	35 (8.5)	20 (9.1)
Total	829 (100)	426 (100)	159 (100)	74 (100)	74 (100)	51 (100)	81 (100)	20 (100)	535 (100)	280 (100)
Episodes of drunkenness*										
Increased	147 (17.7)	62 (14.6)	4 (25.0)	1 (7.7)	4 (8.7)	6 (13.3)	15 (37.5)	3 (17.6)	112 (17.2)	44 (14.5)
Unchanged	472 (59.6)	243 (57.0)	9 (56.3)	9 (69.2)	31 (67.4)	23 (51.1)	17 (42.5)	9 (52.9)	366 (56.2)	175 (57.8)
Decreased	210 (25.3)	121 (28.4)	3 (18.8)	3 (23.1)	11 (23.9)	16 (35.6)	8 (20.0)	5 (29.4)	173 (26.6)	84 (27.7)
Total	829 (100)	426 (100)	16 (100)	13 (100)	46 (100)	45 (100)	40 (100)	17 (100)	651 (100)	303 (100)

CG, Control group; IG, Intervention group.

**Stratified by estimation of frequency of alcohol use.*

Finally, episodes of drunkenness were assessed and only small differences between intervention and control group participants were detected (**Table 3**) with an elevated OR of 1.32 for a decrease in the intervention against the control group (95% CI 0.98-1.80) and with some variation across peer-use perception groups (**Table 4**).

Comparing male and female students, the largest decreases were seen regarding episodes of drunkenness in both sexes and across groups. Changes of similar size were also seen for alcohol consumption, where women in the control group reported markedly higher decreases compared to men in the control group. Interestingly, the proportion of respondents indicating increase of alcohol consumption was also higher in females than in males in the control group. Cannabis consumption changed less among women than men, with about 80% of women and 75% of men reporting unchanged consumption at T1.

To assess sex-specific intervention effects, stratified models were calculated. We saw a significantly elevated odds ratio for decreased alcohol consumption at T1 among both men (OR 2.34) and women (OR 1.71). Most OR estimates were close to the null effect; only for cannabis an elevated OR of 2.02 (95% CI 1.13-3.59) among women was seen for the outcome of non-increased consumption while the result for men was unremarkable. Effects by gender are displayed in further detail in **Tables 4.1**, **5.1**. However, the broadly overlapping confidence intervals do not allow any substantial interpretations about differences in risk estimates between male and female students.

As can be seen in the table for individuals overestimating use at T0 and under-/accurately estimating use at T1 (**Table 6**), there were only four participants with frequent use at T0 (three times per week or more) in the control group, of those two participants reduced their consumption by one category at T1 (50%). In the intervention group, three participants were in the highest frequency of use group, of those two reduced their frequency of use by one category at T1 (66.6%). Looking at participants with moderate frequency of use at T0 (2-8 times/month), of 24 participants in the control group, approximately one third remained in the same category, five participants (20.8%) reduced alcohol use. In the intervention group, a higher percentage of participants moved to the lower category at T1 (12 of 23, 52.2%). Looking at changes in frequency of use among individuals overestimating peer use at both time points, we can see in **Table 7** that, in the control group, 141 participants with frequent use reduced their alcohol use (37 + 1, 26.9%) and 13 + 5 (40.9%) in the intervention group. Among individuals with moderate use, 8.5% reduced alcohol

TABLE 4 | Results of multivariable logistic regression models (total and stratified); Outcomes: alcohol, tobacco, cannabis consumption, and episodes of drunkenness *decreased* 5 months post-intervention.

	Stratified by estimation of peer use at baseline (T0) and follow-up (T1)									
	Total analysis group (n = 1,255)		**Under-/accurately at T0 Under-/accurately at T1**		**Overestimated at T0 Under-/accurately at T1**		**Under-/accurately at T0 Overestimated at T0**		**Overestimated at T0 Overestimated at T1**	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	**p**	**OR (95% CI)**	***P***
Alcohol consumption										
Intervention (IG vs. CG)	**1.91 (1.42-2.56)**	**<0.001**	*	*	**6.28 (2.00-19.8)**	**0.002**	1.82 (0.48-6.90)	0.371	1.86 (1.32-2.63)	<0.001
Tobacco consumption										
Intervention (IG vs. CG)	0.68 (0.38-1.22)	0.194	0.11 (0.00-2.10)	0.139	0.42 (0.03-6.00)	0.520	0.39 (0.06-2.47)	0.315	0.71 (0.31-1.60)	0.406
Cannabis consumption										
Intervention (IG vs. CG)	1.33 (0.67-2.65)	0.414	0.83 (0.26-2.65)	0.753	**11.7 (1.24-110)**	**0.032**	*	*	1.74 (0.44-6.95)	0.430
Episodes of drunkenness										
Intervention (IG vs. CG)	1.32 (0.98-1.80)	0.072	1.34 (0.00-253.0)	0.753	2.45 (0.63-9.48)	0.191	1.84 (0.41-8.26)	0.419	1.27 (0.89-1.82)	0.187

**Sample size in this subgroup was too small to derive reliable estimates (algorithm did not converge).*
CG, Control group; CI, Confidence Interval; IG, Intervention group; OR, Odds ratio; p-value (derived by means of a multivariable logistic regression model, additionally adjusted for alcohol, tobacco, or cannabis consumption or episodes of drunkenness at baseline; University treated as random effect). Bold values indicate significant effects.

TABLE 4.1 | Gender-specific results of multivariable logistic regression models; Outcomes: alcohol, tobacco, cannabis consumption, and episodes of drunkenness decreased 5 months post-intervention.

	Males		**Females**	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***
Alcohol consumption				
Intervention (IG vs. CG)	2.34 (1.44-3.80)	**<0.001**	**1.71 (1.18-2.47)**	**0.004**
Tobacco consumption				
Intervention (IG vs. CG)	0.82 (0.41-1.65)	0.581	0.58 (0.25-1.35)	0.206
Cannabis consumption				
Intervention (IG vs. CG)	1.64 (0.82-3.31)	0.164	1.07 (0.39-3.00)	0.893
Episodes of drunkenness				
Intervention (IG vs. CG)	1.33 (0.77-2.32)	0.310	1.38 (0.93-2.06)	0.110

CG, Control group; CI, Confidence Interval; IG, Intervention group; OR, Odds ratio; p-value (derived by means of a multivariable logistic regression model, adjusted for age and alcohol, tobacco, or cannabis consumption or episodes of drunkenness at baseline; University treated as random effect). Bold values indicate significant effects.

use and approximately twice as many in the intervention group (17.4%).

DISCUSSION

Participation in a web-based PNF was associated with higher odds for decreased alcohol and cannabis use among students enrolled at intervention compared to delayed intervention control Universities. The observed intervention effect may be linked to the fact that, similar to North American and other European student populations (10, 13, 30, 36), German students at the eight Universities enrolled in this study misperceived alcohol and cannabis use in their peer group. As expected, the majority of students at all participating Universities perceived the use of both substances to be higher than the actually assessed prevalences at the Universities at both time points. Further, our results suggest that in the group that had overestimated alcohol use at baseline and under or accurately estimated peer alcohol use at follow-up, reductions in alcohol use were most pronounced.

In addition, an overall intervention effect could be detected for cannabis use among students at intervention compared to control Universities, especially when contrasting increased with decreased use over the course of the follow-up. Similar to the results for alcohol use, students in the group that moved to more accurate perceptions of peer cannabis use over the follow-up benefited the most from the intervention and decreased personal use. However, the numbers of students in the different categories for the analysis of the subgroups were very small. Our results should therefore be interpreted with caution and need to be replicated in a larger sample of German University students. Regarding tobacco use, a different picture emerged. Our study did not demonstrate an intervention effect pertaining to all the substances assessed and no variations by category of peer-use perception were observed. A combination of PNG with other behavior change strategies as part of multicomponent interventions may be more promising for influencing a wider range of substances used. However, it is difficult to separate treatment effects of intervention components and compare multi-component interventions to standalone approaches (37). Further, standalone online-interventions might not be effective enough to change long established addictive behaviors, such

TABLE 5 | Results of multivariable logistic regression models (total and stratified); Outcome: consumption *not increased* 5 months post-intervention.

	Stratified by estimation of peer use at baseline (T0) and follow-up (T1)									
	Total analysis group (n = 1,255)		**Under-/accurately at T0 Under-/accurately at T1**		**Overestimated at T0 Under-/accurately at T1**		**Under-/accurately at T0 Overestimated at T0**		**Overestimated at T0 Overestimated at T1**	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Alcohol consumption										
Intervention (IG vs. CG)	1.36 (0.90-2.04)	0.147	1.22 (0.05-28.3)	0.896	1.20 (0.33-4.31)	0.776	3.23 (0.72-14.5)	0.371	1.14 (0.70-1.85)	0.52
Tobacco consumption										
Intervention (IG vs. CG)	1.34 (0.90-2.01)	0.152	1.46 (0.24-8.97)	0.680	1.84 (0.18-18.7)	0.603	1.69 (0.52-5.57)	0.384	1.27 (0.82-1.98)	0.285
Cannabis consumption										
Intervention (IG vs. CG)	**1.70 (1.13-2.55)**	**0.011**	5.55 (1.25-24.6)	0.024	1.82 (0.51-6.51)	0.355	3.71 (0.43-32.2)	0.231	1.58 (0.86-2.89)	0.142
Episodes of drunkenness										
Intervention (IG vs. CG)	1.26 (0.91-1.75)	0.169	*	*	0.43 (0.09-2.00)	0.278	5.17 (0.71-37.6)	0.103	1.23 (0.83-1.80)	0.301

**Sample size in this subgroup was too small to derive reliable estimates (algorithm did not converge).*
CG, Control group; CI, Confidence Interval; IG, Intervention group; OR, Odds ratio; p-value (derived by means of a multivariable logistic regression model, additionally adjusted for alcohol, tobacco, or cannabis consumption or episodes of drunkenness at baseline; University treated as random effect). Bold values indicate significant effects.

TABLE 5.1 | Gender-specific results of the multivariable logistic regression models; Outcomes: alcohol, tobacco, cannabis consumption, and episodes of drunkenness *not increased* 5 months post-intervention.

	Males		**Females**	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***
Alcohol consumption				
Intervention (IG vs. CG)	1.14 (0.68-1.91)	0.620	1.40 (0.83-2.36)	0.206
Tobacco consumption				
Intervention (IG vs. CG)	1.43 (0.79-2.61)	0.241	1.36 (0.89-2.10)	0.158
Cannabis consumption				
Intervention (IG vs. CG)	1.39 (0.78-2.49)	0.264	**2.02 (1.13-3.59)**	**0.017**
Episodes of drunkenness				
Intervention (IG vs. CG)	1.01 (0.56-1.83)	0.973	1.51 (0.98-2.31)	0.060

CG, Control group; CI, Confidence Interval; IG, Intervention group; OR, Odds ratio; p-value (derived by means of a multivariable logistic regression model, adjusted for age and alcohol, tobacco, or cannabis consumption or episodes of drunkenness at baseline; University treated as random effect). Bold values indicate significant effects.

as tobacco use. Previous research suggests that interventions combining an online intervention with personal counseling led to higher satisfaction (38). It also remains unclear whether the INSIST-intervention challenged the misperceptions. There is a need to also add an assessment of pre- to post-changes in perceived norms to SN studies (15).

Hence, feedback provided to students in our study led to more accurate perceptions of peer alcohol and cannabis use in a relatively small group of students. These changed perceptions, in turn, appeared to be associated with reduced alcohol and cannabis use at 5-months follow-up. Similarly, a study by Su et al. (39) examined the effects of a campus-wide social marketing campaign on alcohol use among 4,172 college students and found that reading campaign messages was associated with more accurate perceptions of peer alcohol use. In addition, and probably, as a result of exposure to the campaign, students reported consuming fewer drinks per sitting and fewer blackouts due to binge drinking at 6-months follow-up. A controlled intervention study targeting Canadian University students found that changes in norm misperceptions at 3-months mediated the effect of e-CHECKUP TO GO, an intervention containing SN feedback and self-monitoring of drinking behavior, on drinking outcomes at 5-months follow-up (40). In a Swedish study, obtaining personalized normative feedback online and *via* IVR was associated with a significant reduction in peak blood alcohol concentrations after 6 weeks in University students (27), while a Swiss study did not find any effects on long-term alcohol use and binge drinking in young men between the ages of 20 and 25 years (28). A systematic review by Riper et al. (21) revealed that web-based interventions that were solely based on personalized normative feedback were less likely to be effective for adult problem drinkers than intervention strategies based on integrated therapeutic principles. Therefore, short web-based interventions aimed at changing misperceived norms may not be sufficient for people already involved in high-risk use (21). Thus, additional research is needed so that interventions can be optimized toward specific target groups. Further, we are not aware of comparable studies examining the effects of PNF on cannabis or tobacco use among University students. Because alcohol, tobacco, and cannabis are different substances associated with varying consequences at the individual level, as well as varying levels of public acceptance, PNF may not work in a unified way. For example, compared to the US, tobacco is less regulated and use is still more socially accepted in Germany,

TABLE 6 | Frequency of alcohol consumption at baseline and follow-up among individuals overestimating peer use at baseline and correctly or underestimating use at follow-up (CG: $n = 46$, IG: $n = 45$).

Frequency of alcohol consumption	CG								IG							
T0 ↓ / T1 →	At most 1x/month		2-8x/ month		3x/week or more		All		At most 1x/month		2-8x/ month		3x/week or more		All	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	N	%
At most 1x/month	17	94.4	1	5.6	0	0	18	100.0	16	84.2	3	15.8	0	0	19	100.0
2-8x/month	5	20.8	16	66.7	3	12.5	24	100.0	12	52.2	11	47.8	0	0	23	100.0
3x/week or more	0	0	2	50.0	2	50.0	4	100.0	0	0	2	66.7	1	33.3	3	100.0
Total	22	47.8	19	41.3	5	10.9	46	100.0	28	62.2	16	35.6	1	2.2	45	100.0

CG, Control group; CI, Confidence Interval; IG, Intervention group.

TABLE 7 | Frequency of alcohol consumption at baseline and follow-up among individuals overestimating peer use at baseline and follow-up (CG: $n = 651$, IG: $n = 303$).

Frequency of alcohol consumption	CG								IG							
T0 ↓ / T1 →	At most 1x/month		2-8x/ month		3x/week or more		All		At most 1x/month		2-8x/ month		3x/week or more		All	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	N	%
At most 1x/month	132	78.1	37	21.9	0	0	169	100.0	82	83.7	16	16.3	0	0	98	100.0
2-8x/month	29	8.5	256	75.1	56	16.4	341	100.0	28	17.4	107	66.5	26	16.1	161	100.0
3x/week or more	1	0.7	37	26.2	103	73.0	141	100.0	5	11.4	13	29.5	26	59.1	44	100.0
Total	162	24.9	330	50.7	159	24.4	651	100.0	115	38.0	136	44.9	52	17.2	303	100.0

CG, Control group; CI, Confidence Interval; IG, Intervention group.

whereas cannabis is still an illegal drug and acceptance varies in different population groups in Germany. Acceptance of cannabis use appears to be higher in young adults aged 18-25, where almost 50% have used cannabis during their lifetime, while in the age group of 12-17 year-olds, only 10% have done so. Alcohol consumption is widely socially accepted with almost 100% of lifetime use in older adults and about 64% in the younger age groups (41). These differences in regulations and acceptance continue to shape social norms.

One limitation of our study was that we could not determine whether students' perceptions changed before the actual substance use behavior or whether perceptions changed as a result of the change or adjustment in behavior. Our sample was a convenience sample and only 2.4% of the enrolled students at Universities completed our baseline survey. Therefore, the observed substance use prevalences are not representative for University students in Germany. As is the case in many internet-based interventions, we had a substantial dropout rate, with only 28% completing both baseline and follow-up questionnaires. Although we were left with reasonable numbers for detailed statistical analyses, this is a potential source of bias which was previously reported for SN-studies (42). However, we were not able to detect small effects as intended. The substance use prevalence for most illicit substances (except for cannabis) assessed in our study was too low to run comparative analyses. Investigating the impact of SN interventions on illicit substances requires further research activities taking low prevalence rates into account. Also, external validity of our results is limited. However, our results add to the large body of evidence demonstrating misperceptions of peer substance use in representative samples and intervention effects of SN-approaches (43). Further, in our study, we did not treat intervention Universities any different from control Universities in terms of attempting to boost participation in the follow-up assessments. Another limitation was that the perceptions of personal and peer substance use, as well as the prevalence of substance use, were not assessed at the delayed intervention control Universities after students there had completed the web-based SNF. Therefore, we do not know whether students at these Universities experienced similar or different changes in the use of licit and illicit substances after 5 months as those noted for students at intervention Universities. Social contacts between students of intervention vs. control Universities in each region of Germany were possible, in principle, but were considered minimal by local study staff. Therefore, we do not think that cross-contamination of intervention effects occurred. Overall, differences in terms of courses offered and size of the student population between the included Universities have to be acknowledged, but we believe that these differences were of limited relevance to the grouped comparisons of intervention and control Universities.

The web-based PNF included feedback on both descriptive and injunctive norms. Any added effect of the injunctive norms feedback could not be determined in this study.

Results of another study suggest that the combination of descriptive and injunctive norms feedback was as effective in reducing the frequency of drinking 2 weeks post-intervention as descriptive-norms-feedback only (20). Hence, a more parsimonious intervention only including the descriptive-norms feedback may suffice to achieve the desired effects on alcohol use in German University students. However, this needs to be the topic of further investigation in this population. Studies with factorial designs involving multiple cycles may be appropriate to test combinations of intervention components and to consecutively replace less effective or ineffective intervention components with effective ones (44).

To conclude, this study was the first cluster-controlled trial examining the impact of an evidence-based intervention addressing SN surrounding various substances targeting German University students. Findings of the INSIST-study suggest that a short web-based PNF can impact alcohol and cannabis use in this population. Contrary to a Cochrane Review on the effects of SN-interventions among University students which did not find meaningful benefits regarding alcohol misuse (45), our results provide a somewhat more positive picture, although effect sizes in our study were limited. Given the character of this low-threshold and comparatively easy to implement intervention at interested Universities, we recommend a more widespread implementation and detailed surveillance of intervention implementation and effects over longer periods of time in this setting.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors upon request.

ETHICS STATEMENT

Because the study involved human participants, ethical approval was obtained from institutional review boards of all participating universities. Data protection was monitored by the local data protection agency in the city state of Bremen. Eight Universities in four regions participated in the study (Hamburg University of Applied Sciences, Hannover Medical School, University of Bielefeld, Heinrich Heine University Duesseldorf, Martin-Luther-University Halle-Wittenberg, Technical University Dresden, Heidelberg University, Mannheim University). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CP: conzeptualization, investigation, writing—original draft preparation, validation, funding acquisition, and visualization. SH: conzeptualization, investigation, writing—original draft preparation, project administration, and visualization. SM: conzeptualization, investigation, writing—review, and editing. HZ: conzeptualization, investigation, writing—original draft preparation, supervision, and funding acquisition. HP: formal analysis, writing—original draft preparation, and visualization. SS: investigation, writing—review, and editing. RR, AS-P, MG, AK, AI, and UW: investigation, writing—review, and editing. All authors contributed to the article and approved the submitted version.

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Just "Like Coffee" or Neuroenhancement by Stimulants?

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Introduction: Pharmacological neuroenhancement (PN) is a topic of increasing importance and prevalence among students. However, there is a lack of differentiating PN substances, according to their psychoactive effects. In particular, there is a lack of data about PN by caffeinated drinks, even if coffee is a common and broadly used Neuroenhancer because of its cognitively enhancing effects regarding wakefulness, alertness and concentration.

Materials and Methods: A web-survey was developed for German students and alumni about the non-medical use of caffeine for PN contained questions about coffee, caffeinated drinks and energy drinks, caffeine pills and methylxanthine tea regarding frequency and further contextual factors.

Results: Six hundred and eighty-three participants completed the survey. Nearly all participants knew about PN (97.7%). 88.1% admitted using some over-the-counter substances. For PN purposes, coffee was used by 72.9% followed by energy drinks (68.2%) and cola drinks (62.4%). Methylxanthine containing tea was used for PN purposes, too (black tea 52.3%, green tea 51.7%). 1.8% admitted using illegal substances or prescription drugs, too.

Discussion: Using legal methylxanthine containing drinks for PN seems to be extremely common with coffee and energy drinks being the preferred substances, while illegal and prescription drugs are only minimally used. Further studies should investigate the awareness of methylxanthine containing drinks as well as its character to be a flavoring drink or a neuroenhancer.

Keywords: caffeine, coffee, energy drinks, neuroenhancement, misuse

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INTRODUCTION

The article "Poll results: Look who is doping" is one of the most cited articles in the field of pharmacological neuroenhancement (PN) (1). In 2008, Nature ran this online poll among their readers to study the frequency and reasons regarding the use of psychoactive substances to enhance cognitive performance. Until today, this article can be considered as "conversation starter." However, meanwhile there are much more studies examining the phenomenon of using substances to increase cognition deeper and much more systematic.

The term "smart drugs" is used for this group of drugs, as well as other synonyms e.g., brain doping, academic performance enhancement, cognitive enhancement or pharmacological neuroenhancement (PN). PN is mostly defined as the non-medical use of divergent psychoactive substances to increase vigilance, attention, concentration or memory by healthy subjects (2–4).

The above mentioned poll assessed the use of methylphenidate, modafinil and beta blockers for cognitive enhancement. The authors demonstrate that 20% of the 1,400 participants had used at least one of the aforementioned substances to improve their focus, concentration or memory without medical need (1). Meanwhile there are several national and international publications about the use of prescription as well as illicit substances for PN. They show lifetime prevalence rates of 1 up to 20% depending on the substances assessed, the survey methods used and other factors (5–10). However, until today there is a paucity of studies regarding legal over the counter (OTC-) substances such as caffeine for PN and their contextual factors. Although, caffeine—standing for the best well-known representative of the chemical group of methylxanthines (such as caffeine, theobromine, theophylline) (11)—has proved pro-cognitive effects [e.g., (12–16)]. Methylxanthines are legal alternative PN substances compared to prescription and illicit substances (e.g., amphetamines, modafinil, etc.). Regarding this comparison, methylxanthines are frequently preferred by several students based on ethical, legal and medical reasons (17). Beyond that, the use of coffee has to be considered as a cultural habit with the well-known "side effect" of having wake promoting properties—especially when being tired (11).

"Real" side effects such as jitteriness, sleeplessness, stomachache etc. have to be considered when using methylxanthine containing substances. Side effects are listed inter alia in the so called "Arzneimittelfachinformation" of the only caffeine containing tablet in Germany (Coffeinum®). Of course, these possible side effects can harm users but they can be considered as "minor" side effects compared to the side effects of amphetamines, methylphenidate or modafinil [e.g., (18)]. Nevertheless, when deciding to use a PN substance, students make their individual decision regarding the choice of the type of the PN substance in parts based on ethical aspects but mainly dominated by medical and legal aspects (17).

Even if caffeinated substances epidemiologically seem to be well-known for PN [e.g., (7, 19–21)], there is a paucity of studies enabling a deeper understanding of this context. For example, Forlini et al. showed that most students knew about the possibility to use coffee, caffeinated drinks and caffeine tablets for PN; in this study 56% indicated a past use of coffee and 41% a past use of energy drinks for PN purposes (20). Franke et al. showed similar results in 2011 (22). In sum, superficial aspects about caffeine for PN have been studied while systematic data about the use of methylxanthines combined with contextual factors for a deeper understanding are missing.

An older survey on caffeine use in university students showed, lifetime, past-year and past-month prevalence rates for the use of coffee specifically for PN of 53.2, 8.5, and 6.3%, for the use of energy drinks of 39, 10.7, and 6.3%, and for the use of caffeine tablets of 10.5, 3.8, and 0.8% (22). Additionally, a survey study among surgeons revealed lifetime, past-year, past-month, and past-week prevalence rates for coffee specifically for PN of 66.8, 61.9, 56.9, and 50.5% (2). For energy drinks they found prevalence rates of 24.2, 15.4, 9.9, and 6.1% and for caffeine tablets of 12.6, 5.9, 4.7, and 3.8% (2). Both studies showed the use in light of stress, pressure to perform and reduction of fatigue (2, 22). However, these and other studies do not give deeper insights in methylxanthine use for PN such as psychotropic and side effects, the amount of used cups of coffee per day, product names of energy drinks, etc.

The mechanism of action of methylxanthines has been investigated in the past (11) and leads to states of increased cognitive abilities (reduced fatigue, increased wakefulness, concentration, shortened reaction time, etc.) (2, 23, 24). Clinically, pro-cognitive effects of caffeine have been shown to be comparable to effects of stimulants such as amphetamines: Randomized controlled trials showed 600 mg of caffeine to have comparable clinical effects to 20 mg of dextro amphetamine or 400 mg of modafinil in healthy sleep-deprived subjects (at least regarding the restoration of simple psychomotor performance and objective alertness) (13–15). Beyond that, a comparison between coffee and the so called "energy drinks"—having additional ingredients such as taurine—showed that energy drinks have stronger clinical effects regarding cognitive PN domains than coffee (25).

Beyond coffee, methylxanthine containing tea and energy drinks, there are caffeine pills containing different amounts of caffeine. In Germany, Coffeinum® is sold in specialized pharmacy stores, each pill containing 200 mg of caffeine. It is approved for short time reduction of tiredness. This amount of caffeine "per pill" is less than the amount of caffeine usually found in a grande coffee in a coffee shop containing more or less 500–600 mg of caffeine.

The character of caffeine has three different faces: (1) coffee primarily as a flavoring beverage, (2) energy drinks (and other beverages and foods) containing caffeine as a food supplement, and (3) caffeine tablets that have to be regarded as a drug/medication.

Summing up, caffeine in various routes of administration seems to be a widespread PN drug. The present web-based study was designed to improve the current database on knowledge and prevalence rates by further contextual factors such as differentiating methylxanthines, frequency and amount of use and further factors such as effects, side effects as well as a combination with other psychoactive substances.

Therefore, this preliminary study assessed a convenience sample of students, alumni and associated people at a University of Applied Sciences (UAS) in Mecklenburg-Vorpommern, a federal German state, about their use of methylxanthine containing substances and drinks. For a literature comparison and for having a basis about PN drug use, data about the general knowledge of PN and the use of prescription and illicit substances were collected, too. However, mainly this preliminary study wants to open a new chapter of methylxanthines research for PN.

TABLE 1 | Basic characteristics of the survey participants ($n = 683$).

Age[a]	$M = 26.6$	$SD = 6.6$
Gender	Male	187 (27.4%)
	Female	496 (72.6%)
Profession	Students and trainees	555 (81.3%)
	Employees	93 (13.6%)
	Double stress[b]	22 (3.2%)
	Others	13 (1.9%)

Mean (M) and standard deviation (SD), or number and percentage of participants are shown.
[a]*Age in years.*
[b]*Meaning students that are also employed.*

MATERIALS AND METHODS

The present study was designed as an online survey using the survey tool "Unipark" and distributed among employees, students and alumni of the University of Applied Sciences (UAS) in Neubrandenburg (NB), in Mecklenburg-Vorpommern, a federal state in north-eastern part of Germany. Announcements for the survey were distributed *via* electronic media: homepage, social media and mailing lists of the above mentioned UAS. The invitations were posted and mailed in June 2016; the survey was opened between July and September 2016.

In total 717 participants participated in the survey. Participants with missing data ($n = 34$; 4.7%) had to be excluded. The remaining 683 participants have been included in the analysis of the survey.

The data was acquired using a self-designed online survey to ensure a high degree of privacy and anonymity for all participants. Before the questionnaire starts, participants were informed about the aim and the content of the questionnaire. A section explaining the emphasis on caffeine use for PN was given in bold letters. The chemically correct term "methylxanthine" was avoided and replaced by the word "caffeine" to make the emphasis clearer for all participants.

PN was defined in the introduction of the questionnaire to be the use of divergent substances (drugs and drinks) with the specific aim to increase cognition (e.g., wakefulness, attention, concentration, memory) without needing these substance(s) as a medication because of an existing disease.

Description of the Questionnaire

The questionnaire was built as follows: after questions about demographic data (sex, age, professional status: student, employed, student and employee, other), the questionnaire asked for data about knowledge of PN drugs in general to build a basis of PN data comparable to the present literature: having ever heard about those by type of source of knowledge [print media, TV, internet, colleagues, friends/relatives, (other) students], type/class of substance: over-the-counter (OTC) drugs (including caffeine, Ginkgo biloba, etc.), prescription drugs (methylphenidate, e.g., Ritalin®) and illicit drugs (illicit amphetamines e.g., "Speed"); having used substances with the particular intention of PN and frequency (never, during last month, during last year, longer than 1 year ago) of the use of (a) coffee, (b) energy drinks (e.g., Red Bull®), (c) caffeine pills (e.g., Coffeinum®), (d) caffeine drinks (e.g., Coca Cola®), (e) black tea, (f) green tea (g) illicit drugs, and (h) prescription drugs.

The questionnaire then opened a new chapter on the use of methylxanthine containing substances for PN and asked the following questions about aspects of using methylxanthine containing substances: age at first use, motivation/reason for the use, the subjectively observed/felt neuroenhancing effects, side effects, the habit of mixing the energy drink with alcohol, average number of cups of coffee used per day (not for PN purposes). For each energy drink, participants had the possibility to specify the brand name.

A pre-test of the questionnaire was conducted among a dozen of voluntary participants. Based on this pre-test, the questionnaire was adapted for the survey. Especially the wording (methylxanthine → caffeine containing, caffeinated → drink energy drink) was changed to increase understandability for future participants.

Data Analysis

Data were collected and stored in the Unipark database. Data were extracted as an Excel file and converted to SPSS (Ver 25.0) which was used for statistical calculations. Variables had to be (re-) named/characterized according to the variables of the questionnaire.

Binary univariable logistic regression analyses were used to predict the use of OTC or illicit and/or prescription drugs, respectively. As predictor variables age, gender and professional status were included. For non-normally distributed continuous variables, Mann-Whitney U test was applied to test for differences in the mean between two groups. For two normally distributed variables a *t*-test was performed. The association between categorical variables was assessed by means of Fisher's exact-test. For all analyses we consider a *p*-value of below 0.05 indicating statistically significant effects. Since our study was designed as a first, preliminary explorative study, no *p*-value adjustment for multiple testing was considered.

In the first part of the questionnaire about PN in general, single substance names (e.g., methylphenidate, amphetamine, speed, etc.) were used to simplify the answering process for all participants. Consistent with the focus of the study (methylxanthines for PN), substance names were grouped as follows: Participants who reported using "Speed," Ritalin®, cocaine, Neurodoron®, ephedrine, amphetamines (including illicit), prescription drugs for insomnia, ecstasy, MDMA, or other illicit substances were categorized as those using illicit or prescription drugs for PN. Prescription and illicit drugs were not specifically distinguished.

Ethics Statement

The study was performed according to the Declaration of Helsinki (1975, revised 2000). Participants gave informed consent by clicking on a button after reading a short introductory paragraph and by pressing the button "done" at the end of the survey. This procedure as well as the whole study was approved

TABLE 2 | General knowledge of pharmacological neuroenhancement according to the type of source where this knowledge came from.

Have you ever heard about neuroenhancement drugs?	Yes	Print media	TV	Internet	Colleagues	Fellow students	Friends and family
	667 (97.7%)	$n = 321$ (47.0%)	$n = 386$ (56.5%)	$n = 372$ (54.5%)	$n = 163$ (23.9%)	$n = 386$ (56.5%)	$n = 355$ (52.0%)

TABLE 3 | Use of OTC an illegal/prescription drugs according to the professional status ($n = 683$).

Professional status	OTC drugs	Illegal/prescription drugs
Employees	89.2% ($n = 83$)	1.1% ($n = 1$)
Students	88.1% ($n = 489$)	2% ($n = 11$)
"Double-stress"	95.5% ($n = 21$)	0%
Others	69.2% ($n = 9$)	0%

by the responsible ethics committee (Neubrandenburg; Approval No. BB 045/14).

RESULTS

Most of the participants were female (72.6%), with a mean age of 26.6 years (**Table 1**). The main group that participated in the survey were students (81.3%). Further participants were recent alumni of the same university and were employees, or built a group of "double-strain" persons (due to their status as students as well as employees) (see **Table 1**).

Almost all of the 683 participants (97.7%) had already heard about the possibility of using substances for PN purposes (see **Table 2**). Knowledge about PN substances came from fellow students (56.5%), TV (56.5%), the internet (54.5%), friends and family (52.0%), and print media (47.0%). Sharing the knowledge about PN with colleagues was reported considerably less often (23.9%).

After the above mentioned general question about participants' knowledge of PN, the questionnaire asked explicitly for the use of methylxanthine containing substances/drinks for PN (see **Table 3**).

The vast majority of all participants (88.1%, $n = 602$, lifetime prevalence) admitted to have used some of the methylxanthine containing OTC substances. Only 1.8% of all participants admitted to use illegal or prescription substances (without medical prescription). The use of OTC and/or illegal substances according to the professional status is shown in **Table 2**. These results suggest that the rates among employed persons and students, when it comes to using OTC substances, are equally high. However, prevalence rates among double stressed (being student as well as employee) participants were higher (95.5%) (see **Table 3**).

No gender differences between the use of methylxanthine containing OTC substances for PN or the use of illegal or prescription substances for PN could be found ($p = 0.963$). The same applies for the association between professional status and gender (data not shown).

Regarding the frequency (ever, last year, last month) of using methylxanthine containing substances/drinks for PN, the most commonly used substance/drink was coffee (72.9%) followed by energy drinks 68.2% and cola drinks (62.4%). Methylxanthine containing tea was used for PN purposes, too: Fifty two percent of the participants used black tea and 51.7% green tea. Regarding caffeine tablets, lifetime prevalence was 28.7% (for further data see **Table 4**). Only 1.8% of the participants admitted using illegal substances or substances only available on prescription (data not shown in the table). The most often reported illegal/prescription substances were amphetamine type substances (0.5%). Prevalence rates during "the last 30 days" were considerably higher than the use of "more than 12 months ago" and the use "within the last 12 months" which was applicable for all methylxanthine containing substances/drinks except caffeine pills. The most frequently used PN substance/drink (49.5%) was coffee. For more details, please see **Table 4**.

Binary univariable logistic regression analyses showed that none of the independent variables (age, gender, professional status) could predict the use of OTC or illicit and prescription substances, respectively (data not shown). Regarding the sources of information of PN and use of OTC substances for PN, only the category "knowing about it from other students" gained statistical significance ($p < 0.05$).

Regarding the brand names of the energy drinks, the most frequently used energy drink was Red Bull® ($n = 268$, 39.2%) followed by Monster® ($n = 118$, 17.3%), Rockstar® ($n = 100$, 14.6%) and Relentless® ($n = 68$, 10.0%) and further brands that are less well-known (e.g., Bullit Energy®, Magic Man®, Grizzly Energy®, Bizz up Energy®, Black Cat®, etc.).

Age of first use (mean values, M, ± standard deviation, SD) were for coffee 16.0 ± 2.9 years and for energy drinks 16.7 ± 3.8 years, for caffeine pills 19.1 ± 3.5 years, for cola drinks 10.5 ± 3.3 years, for black tea 14.8 ± 4.9 and for green tea 16.9 ± 5.4 years (see **Table 5**).

Asked for specific situations in which methylxanthine containing substances/drinks were used, the most frequently named situation was tiredness ($n = 305$, 44.7%). This aspect was followed by the items work during nights ($n = 251$, 36.7%), examinations and stress associated with examinations ($n = 167$, 24.5%), stress associated with pressure to perform (in general) ($n = 152$, 22.3%), cognitively demanding work ($n = 137$, 20.1%) as well as learning (in general) ($n = 131$, 19.2%), somatic demanding work ($n = 71$, 10.4%), time pressure ($n = 59$, 8.6%), boredom ($n = 46$, 6.7%) and a bad mood (in general) ($n = 28$, 4.1%) (see **Figures 1**, **2** and **Table 6**).

According to the above mentioned situations the most frequently stated aim was the reduction of tiredness ($n = 349$,

TABLE 4 | Prevalence rates for the use of legal neuroenhancement substances.

Substance used for neuroenhancement	Never	Within the last 30 days	Within the last 12 months	More than 12 month ago
Coffee	185 (27.1%)	338 (49.5%)	98 (14.3%)	42 (6.1%)
Energy drinks	217 (31.8%)	216 (31.6%)	120 (17.6%)	93 (13.6%)
Caffeine pills	487 (71.3%)	17 (2.5%)	28 (4.1%)	75 (11.0%)
Cola drinks	257 (37.6%)	227 (33.2%)	107 (15.7%)	52 (7.6%)
Black tea	326 (47.7%)	147 (21.5%)	109 (16.0%)	48 (7.0%)
Green tea	330 (48.3%)	137 (20.1%)	111 (16.3%)	46 (6.7%)

TABLE 5 | Age of first use of methylxanthines for neuroenhancement.

Methylxantine used for neuroenhancement	Age of first use
Coffee	16.0 ± 2.9 years
Energy drinks	16.7 ± 3.8 years
Caffeine pills	19.1 ± 3.5 years
Cola drinks	10.5 ± 3.3 years
Black tea	14.8 ± 4.9 years
Green tea	16.9 ± 5.4 years

51.1%). Further frequently stated aims were increase of attention and concentration (attention: $n = 188$, 27.5%; concentration: $n = 204$, 29.9%), increase of somatic performance and reduction of stress/pressure to perform (each $n = 99$, 14.5%) (see **Figures 1**, **2** and **Table 6**).

Participants were asked if they had felt an increase regarding somatic and cognitive performance after having used a methylxanthine containing substance/drink: 21.2% ($n = 145$) had felt an increase of somatic performance and 28.4 ($n = 194$) of cognitive performance.

The most common side effects were tachycardia ($n = 113$, 16.5%), pronounced restlessness ($n = 79$, 11.6%), sleeplessness ($n = 71$, 10.4%), jitteriness ($n = 63$, 9.2%) and nervousness ($n = 65$, 9.5%). Infrequent side effects were stomachache ($n = 34$, 5.0%), headache ($n = 24$, 3.5%) as well as nausea and vomiting ($n = 19$, 2.8%) (see **Table 7**).

Regarding the question, whether participants had mixed energy drinks with alcohol, 9.5% ($n = 65$) stated that they had never done this, 9.4% ($n = 64$) during the last 30 days, 18% during the last year ($n = 123$) and 20.5% ($n = 140$) during a period longer than 1 year ago.

Daily use of coffee varied between one and eight cups (see **Table 8**): 35.0% ($n = 239$) reported to drink one cup per day, 14.9% ($n = 102$) two cups, 8.2% ($n = 56$) three cups, 3.5% ($n = 24$) four cups, 2.3% ($n = 16$) five cups, 1.3% ($n = 9$) six cups, no one seven cups and 0.3% ($n = 2$) eight cups.

DISCUSSION

The present study focused on a population of students and recent alumni from a German university. During this life phase, exams and first challenges of the new job after graduation might increase the desire to enhance the cognitive performance. However, the decision has to be made whether a legal—which means a methylxanthine containing substance or drink in most cases—or an illegal substance (e.g., amphetamine) should be used for PN. According to higher prevalence rates for caffeinated substances compared to prescription/illicit substances, this study as well as previous studies (8, 21, 22, 26) show, that the majority of subjects tend to the use of a legal substance. This is, in most cases, a methylxanthine containing substance or drink. Therefore, we evaluated the use of "soft" neuroenhancement with caffeinated drinks and substances (caffeine pills) that were used only for the purpose to stimulate cognition (PN). Not all participants were willing to fill out the questionnaire about the use of PN substances and drinks. It could be shown that coffee with a consumption rate of over 70% was the most widely used drink for PN. The next most frequently used substances were energy drinks with a level close to 70%. Taken all caffeinated drinks together, over 88% of all study participants reported to use these drinks for PN.

The current cognitive enhancement debate about academic performance is dominated by the misuse of "prescription drugs" (8). The current study as well as studies from 2011 and 2013 (8, 21) observed low rates for the use of prescription and illicit substances, while others found higher proportions: A French study showed that nearly 70% of medicine/pharmacy students used neuroenhancers within the last 12 month (27). In our study sample the prevalence rates for the use of illegal drugs and prescription drugs (use without medical prescription) was only 1.8%. However, the question for using prescription and/or illicit drugs for PN in the present study was only asked to establish a basis to enable a comparison to other studies. Main focus of this preliminary study was raising data about the use of methylxanthines for PN leading to the problem, that there are nearly no similar studies.

The above mentioned lifetime prevalence of 1.8% for prescription/illicit substances is more or less similar to a previous German study where students showed a life-time prevalence for prescription drugs (e.g., amphetamines, methyphenidate) of 0.8% (last-year and last-month prevalence rates were much lower). For the use of illicit drugs, a life-time prevalence for 2.9% was reported for this student group (22). This previous study as well as the present study are in contrast to a study of Maier et al. (8). In our sample of students and associates of the university of Neubrandenburg, the use of prescription substances like methylphenidate was minimal compared to their

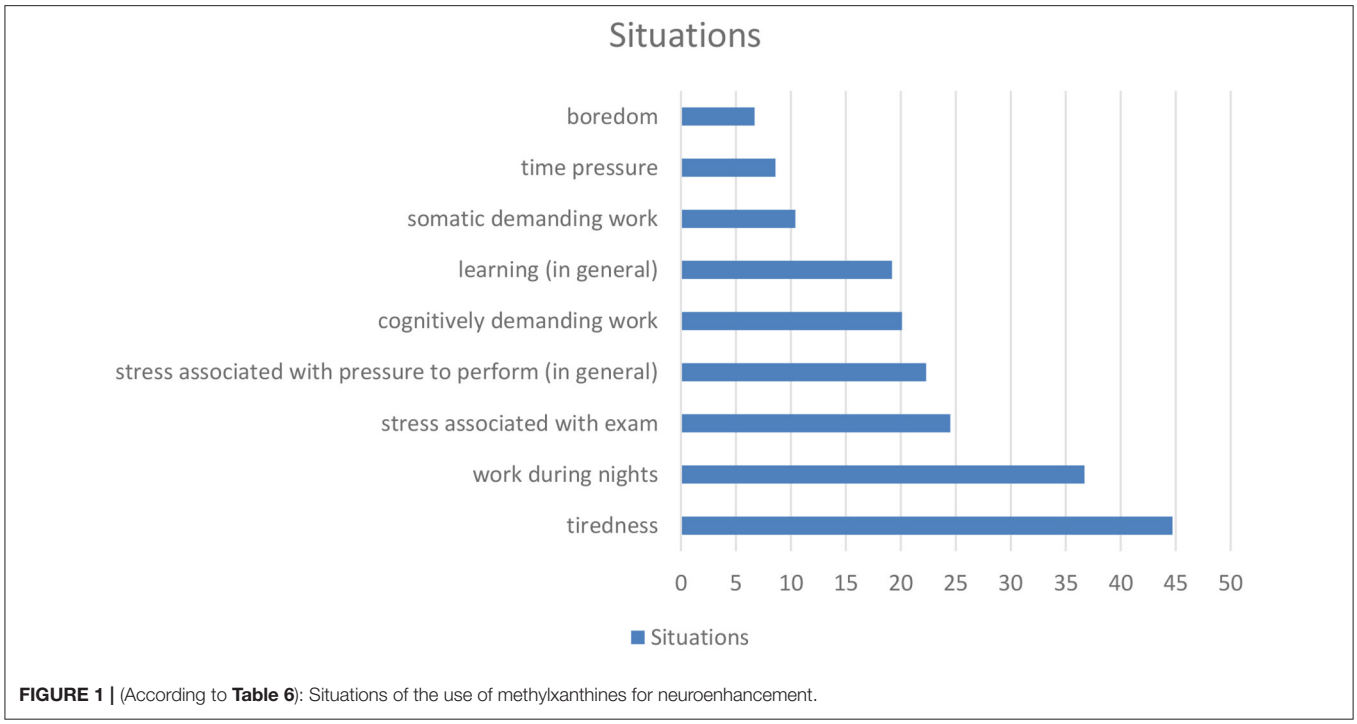

FIGURE 1 | (According to **Table 6**): Situations of the use of methylxanthines for neuroenhancement.

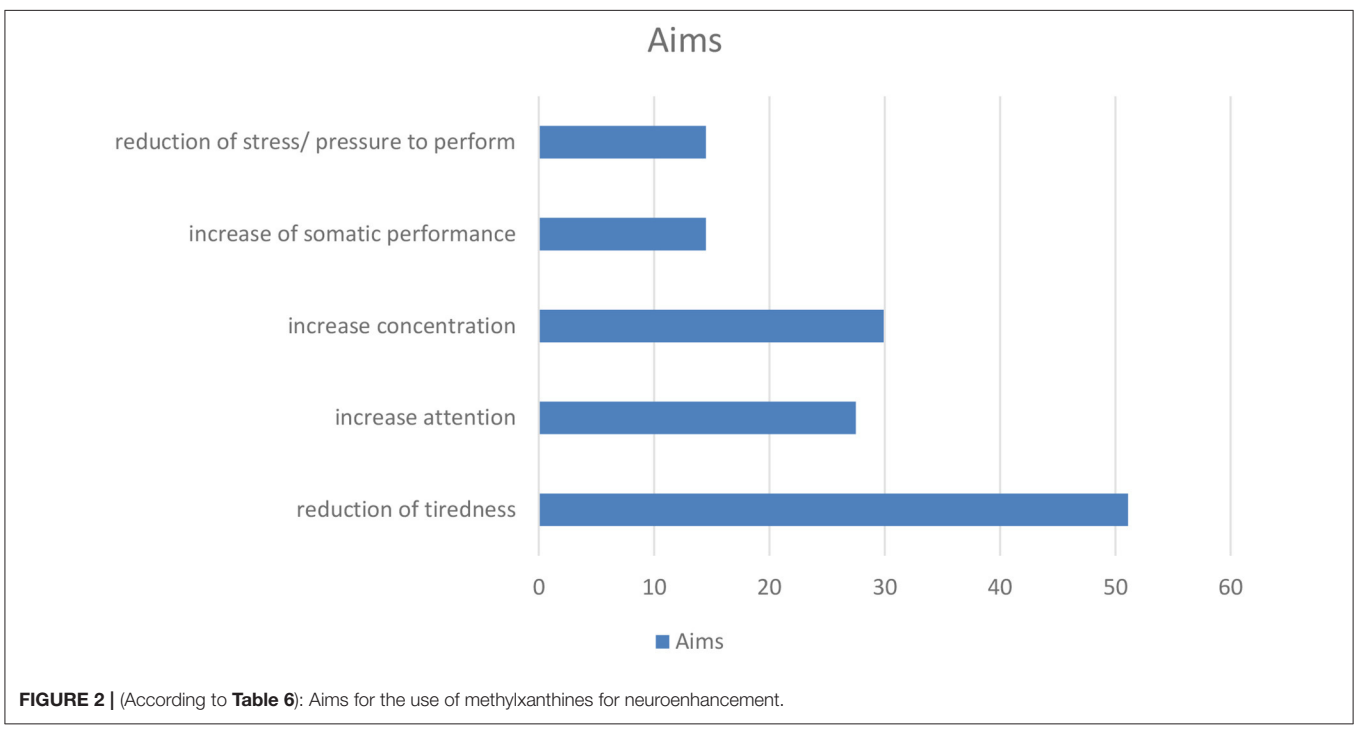

FIGURE 2 | (According to **Table 6**): Aims for the use of methylxanthines for neuroenhancement.

results. Reason for these differences might include the rural area of Neubrandenburg with possibly less opportunities of getting inappropriate access to drugs on prescription. Another reason could also be different regulations and laws varying from Switzerland to Germany and participant's average age.

In contrast to prescription substances, caffeinated drinks offer a legal alternative for neuroenhancement and are already widely used for leisure use. The fact that the vast majority of students in this study used coffee, green tea (e.g., Club-Mate®), energy drinks (e.g., Red Bull®) and cola drinks to enhance their

TABLE 6 | Situations and aims for the use of methylxanthines are used for neuroenhancement.

Situations	Aims
Tiredness ($n = 305$, 44.7%)	Reduction of tiredness ($n = 349$, 51.1%)
Work during nights ($n = 251$, 36.7%)	Increase attention ($n = 188$, 27.5%)
Stress associated with exam ($n = 167$, 24.5%)	Increase concentration ($n = 204$, 29.9%)
Stress associated with pressure to perform (in general) ($n = 152$, 22.3%)	Increase of somatic performance ($n = 99$, 14.5%)
Cognitively demanding work ($n = 137$, 20.1%)	Reduction of stress/pressure to perform ($n = 99$, 14.5%)
Learning (in general) ($n = 131$, 19.2%)	
Somatic demanding work ($n = 71$, 10.4%)	
Time pressure ($n = 59$, 8.6%)	
Boredom ($n = 46$, 6.7%)	
Bad mood (in general) ($n = 28$, 4.1%)	

TABLE 7 | Side effects.

Side effects	Participants
Tachykardia	16.5% ($n = 113$)
Pronounced restless	11.6% ($n = 79$)
Sleeplessness	10.4% ($n = 71$)
Jitteriness	9.2% ($n = 63$)
Nervousness	9.5% ($n = 65$)
Stomachache	5.0% ($n = 34$)
Headache	3.5% ($n = 24$)
Nausea and vomitus	2.8% ($n = 19$)

TABLE 8 | Daily cups of coffee.

Cups of coffee per day	Participants
One cup	35.0% ($n = 239$)
Two cups	14.9 ($n = 102$)
Three cups	8.2% ($n = 56$)
Four cups	3.5% ($n = 24$)
Five cups	2.3% ($n = 16$)
Six cups	1.3% ($n = 9$)
Seven cups	/
Eight cups	0.3% ($n = 2$)

cognitive performance was somehow surprising. This also means that only a minority of students does not take any substances for PN.

For the majority of participants in our study, the use of caffeinated led to side effects such as sleep disturbances. Caffeinated beverages have been shown to provoke a dose dependent negative effect on sleep onset, time and quality (28). This is in line with the data of the "Arzneimittelfachinformation" according to the regulatory affairs of the EMA (European Medicine Agency) for caffeine tablets. This is due to the mechanism of action of caffeine being the same in all methylxanthine containing substances/drinks (green and black tea as well as in coffee, energy drinks and caffeine tablets).

In our study, we did not find any significant differences regarding OTC or illicit/prescription substance use between men and women, respectively. Previously it has been shown that male students are more likely to use stimulants to improve cognitive performance than female students (9, 29). Beyond that, we could show that only "knowing the experience" of PN from others was able to predict the own use of these stimulants. This clearly indicates that peer effects do play a strong role in this cohort of students and recent alumni.

Motives of caffeine consumption have been evaluated in detail before: Alertness, mood, social, taste, habit and symptom management were factors identified. The motive "taste" appeared highly important among all types of caffeine users (30). This could mean that the widespread flavor motive is a consequence of the association of the flavor with the negative reinforcing effects of caffeine. However, the aspect of "flavor" or "taste" was not addressed in the questionnaire because of the strong focus on PN.

Regarding the situations in which methylxanthines are used, the present study shows tiredness, work during nights, stress, pressure to perform, somatic and cognitively demanding work, learning and time pressure to be the most prevalent situations. The aims (reduction of tiredness, increase of attention and concentration, increase of performance, reduction of stress) are tightly associated with these situations. This could mean that methylxanthine use may be an "instrument" to cope with the above mentioned situations.

Demanding situations being reasons for PN substance use as well as the above mentioned aims are in line with a previous study about caffeine use among surgeons (31). The study by Franke et al. revealed pressure to perform to be a highly relevant motive for the use of caffeine. These are the same situations in which prescription and illicit stimulants are used for PN among surgeons (32). Beyond that, the situations are quite similar among students regarding the use of caffeine, prescription and illicit substances for PN purposes (8, 21, 22, 26). This leads to the assumption that PN drug use of prescription and illicit substances can be considered as a coping strategy, too (33). Showing similar situations and aims for the use of methylxanthines for PN, the concept of coping strategies seem to be applicable for methylxanthine use (drug and drink) assessed in the present study. PN by prescription/illicit substances seem to have a similar basis as PN by methylxanthine substances/drinks. However, a previous study has shown, that the decision of students to consider prescription/illicit stimulants or caffeine is mainly based on a subjective evaluation of medical and legal (as well as ethical) aspects (17).

Regarding the brand names of the energy drinks, there are no scientific comparable studies. However, Red Bull® seems to be the most widespread and well-known energy drink, at least in our study.

Beyond that, years ago, the question of a risk of dependence caused by the use of methylxanthines has been denied (34). However, in our study energy drinks such as Red Bull® are used

together with alcohol. This confirms previous studies showing this habit to be associated with the aspect of "partying" (35, 36). However, out study cannot contribute data to the aspect of using energy drinks with alcohol for partying reasons.

The present study also has some limitations: Firstly, the study took place at just one university and the sample size was relatively small. Furthermore, the group of participants was not completely homogenous (students, alumni, double stressed being students as well as employees). However, the majority of the surveyed students stated to belong to the group of students. Since the survey was spread by social media and other online platforms, anybody could have participated, not only students/alumni of the mentioned university. In summary, our observations cannot be generalized to the whole group of German students. The present study, even if preliminary, is a contribution to the field, adding data and new insights to an underinvestigated field which has to be considered as a strength. Further studies with preferably more representative data need to be conducted in the future. Secondly, mental disorders like depression, insomnia or attention deficit disorder (ADHD) were not taken into consideration even though these disorders might alter the use of neurostimulants. Thirdly, beyond the physically and mentally stimulating effect of methylxanthines, there are two further aspects of methylxanthines use: (a) a flavoring aspect of the taste of caffeine and (b) the question of a cultural habit. Even if the questionnaire stressed the PN aspect, it has to be considered that some participants may have merged the three aspects in their mind which may have led to less exact results.

Finally, there is a high prevalence of using OTC substances such as methylxanthines for PN compared to the use of prescription/illicit substances. Furthermore, there seem to be an enormous pressure to perform among students and alumni. If this pressure persists, a "switch" from the use of OTC substances to prescription/illicit substances may occur according to the so called gate-way hypothesis (the use of legal substances may reduce the obstacle to use prescription/illicit substances) (19).

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 Neubrandenburg, Approval No. BB 045/14. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AF was responsible for the study design, development of the questionnaire, and for data acquisition. GK, DK, LP, and AC were responsible for the analysis of the data. The aforementioned authors together with MS, TJ, and OP contributed to the writing process of the manuscript and the process of reading process. All authors contributed to the article and approved the submitted version.

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Finding the Right Balance: A Social Norms Intervention to Reduce Heavy Drinking in University Students

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Introduction: Heavy alcohol consumption constitutes a major health risk among University students. Social relationships with peers strongly affect University students' perception of the drinking behavior of others, which in turn plays a crucial role in determining their own alcohol intake. University students tend to overestimate their peers' alcohol consumption – a belief that is associated with an increase in an individual's own consumption. Therefore, we implemented a social norms intervention with personalized normative feedback at a major University in Germany to reduce and prevent excessive drinking among University students.

Methods: Our intervention was part of a regular health monitoring survey. We invited all enrolled University students to take part in this survey on two occasions. A total of 862 University students completed the questionnaire, 563 (65.3%) of which received e-mail-based feedback upon request concerning their peers' and their own alcohol consumption. For the intervention group ($n = 190$) as well as the control group (no feedback requested; $n = 101$), we included only University students in the evaluation who overestimated their peers' alcohol use and indicated above average consumption of the peers. We applied analyses of variance to assess intervention effects with regard to the correction of overestimated group norms as well as University students' drinking behavior.

Results: Within the intervention group, we observed a significantly larger reduction of the previously overestimated behavioral norms compared to the control group ($p < 0.001$; $\eta_p^2 = 0.06$). With regard to behavioral outcomes the intervention group showed a significantly larger reduction in the AUDIT-C score ($p = 0.020$; $\eta_p^2 = 0.03$).

Discussion: Our study confirms previous research whereupon personalized, gender-specific and selective normative feedback is effective for alcohol prevention among University students. However, University students still overestimated their peers' alcohol intake after the intervention. Furthermore, we did not reach high-risk groups (University students with the highest alcohol intake) since no feedback was requested.

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Future studies should address factors influencing the impact of the intervention and reachability of selective groups.

Keywords: social norms intervention, prevention of alcohol misuse, University students, alcohol intervention, heavy drinking

INTRODUCTION

Harmful use of alcohol causes about 3 million deaths each year and more than 130 million disability-adjusted life years (1). The mortality caused by alcohol is higher than that caused by diseases such as tuberculosis, HIV/AIDS, or diabetes (1). Constant alcohol use causes social impairments and increases the risk for various serious diseases, like alcoholic cirrhosis, tumors and cancer, as well as premature mortality (2, 3). Especially younger adults are disproportionally affected by alcohol: More than 13% of all deaths between 20 and 39 are attributed to harmful use of alcohol (1). The highest prevalence rates of alcohol use disorders are in high-income countries, especially in Europe and in the US. Heavy alcohol consumption is also highly prevalent among young adults in Germany: 42% of men and 33% of women between 18 and 29 display heavy consumption patterns (4). Research suggests that—within this age group—University students tend to drink even more (5, 6) and also more frequently (5) than their non-University peers. Alcohol consumption is widespread among German University students: On average, two thirds of the University students drink alcohol at least twice a month. Nearly one third of the University students report binge drinking at least once a month, and more than 40% show problematic drinking behavior, i.e., an AUDIT-C sum of at least 3 in women and at least 4 in men (7).

Consequently, and due to these high prevalence rates of heavy alcohol consumption and negative outcomes concerning health, social life and society in general there is a particularly high urgency to address the alcohol consumption of University students with proper interventions in order to prevent early-onsets of heavy drinking behavior. These interventions need to simultaneously reduce the harmful use of alcohol and strengthen responsible and low-risk handling of alcohol.

How Do Peers Affect University Students' Alcohol Consumption?

Heavy drinking behavior is affected by intrapersonal and interpersonal social and normative factors (8). Among University students, social relationships with peers play a crucial role for their drinking behavior (9). Accordingly, University students report drinking motives such as social enhancement, enjoyment, and socialization (10, 11). As a pioneer of social conformity theory, Asch (12) showed the impact of social pressure on individual behavior more than six decades ago. The perception of others' behavior—especially peers—affects University students' alcohol consumption through social norms as social influences (13). Moreover, University students adopt the drinking patterns they perceive in their peers. To prevent heavy alcohol consumption, interventions could therefore address social influences through social norms.

Why Do University Students Overestimate Their Peers' Alcohol Consumption?

The perception of behavior is biased and therefore often differs from the behavior actually shown (14). This discrepancy is particularly noticeable in alcohol consumption (15, 16). The core of such misperceptions usually lies in an overestimation of others' risk behaviors and an underestimation of health-promoting behaviors (13). Several studies at US (17–19) as well as European universities (20–22) showed that University students systematically overestimate their peers' alcohol consumption. Thus, the fact—and behavioral norm—that the majority of University students use alcohol responsibly is disguised by individual misperceptions (19). Within literature on the causes for this overestimation, there are several explanations: First, it is argued that overestimation is due to the size of the peer group. As there is little/no information about unknown persons within the peer group there is a lack of information on their alcohol use and thus overestimation occurs (23, 24). Second, it was postulated that among the peer group only close peers (e.g., significant others) are used for estimating alcohol use. Thus, overestimation is a product of "underinclusion" as significant others are only a part of the peer group. However, this approach was disproved when being tested empirically (25). Third, it is proposed that this overestimation is due to a cognitive bias resulting in better memory and attention for more extreme behavioral patterns. Furthermore, this more extreme behavior is regarded as transsituationally consistent (26). Finally, overestimation of peers' alcohol use is found to be moderated by time (e.g., "seasonal effects") as well by own alcohol intake as well as by a loss of self-control (25). This may eventually result in risky drinking behavior since misperceived behavioral norms may encourage individuals to adapt their alcohol intake to what they (mis-)perceive in their peers (13). The *social norms intervention* and *personalized normative feedback* approaches promisingly attempt to break this cycle [i.e., "you (unintentionally) drink more because you expect higher intake levels of your own based on peers' evaluation"; (13)].

How Could We Change the Overestimation?

The *social norms intervention* (SNI) is a health-promoting intervention that aims to correct misperceptions by providing information about the behavioral norm in a population in order to support more health-conscious decision-making processes (27). This intervention approach assumes that correcting the misperceived behavioral norm by replacing it with the actual norm reduces the individual's pressure with regard to the mistakenly overestimated peer consumption (27). The SNI is based on two basic assumptions: (1) accurate information about

the beliefs and behaviors of relevant others is not always known and salient, (2) providing the behavioral norm may change the understanding of group norms and one's own position within the group (28). The SNI differs from traditional behavioral change approaches. It focuses on indirect methods of persuasion by presenting information about (health-conscious) behavioral norms that already exist within a group (29). SNIs do not aim to change the behavioral norms but to correct misperceptions of that behavioral norm (13). The given information is a positive statement showing that responsible and moderate behavior is the behavioral norm, and that the group majority acts and thinks health-consciously (30).

With *personalized normative feedback* (PNF), each person receives individual, personal feedback, e.g., on their own as well as their peers' alcohol consumption (28). For this purpose, a mode of communication is chosen that allows for this kind of feedback, like face-to-face conversations in counseling (31), e-mails (32) or web-based messages via a personal link to a website (33).

What Is the Current Evidence?

Intervention studies (34–38) and systematic reviews (27, 39, 40) demonstrate small to medium effects of SNIs on various alcohol-related outcomes such as drinking quantity, frequency and risky drinking. However, these results often do not persist in the long term. Neighbors et al. (37) showed significant short-term effects of their intervention (PNF, specifically) but no long-term effects on the individual estimation of the behavioral norms, alcohol frequency and quantity. Foxcroft et al. (41) reported inconsistent results in their meta-analytical review: While some studies found significant short- and long-term effects of SNIs and PNFs on alcohol quantity and binge drinking, other studies did not [see also (42)]. Additionally, the overall effect size was very small. However, Dotson et al. (43) declared even small effects as clinically relevant from a public health perspective. Referring to the "prevention paradox" even small improvements at the individual level might achieve large health gains at the population level. In their review, PNF was proven an effective stand-alone approach for reducing college student drinking (43). Moreover, some recent studies were able to obtain medium- and long-term effects of PNFs on drinking frequency after 3 months (44) and drinking prevalence after 6 months (45).

PNF has proven to be effective in correcting misperceived drinking behavioral norms (37, 46, 47). This modification of misperceived behavioral norms has been found to mediate the relationship between PNF and behavioral outcomes with regard to reduced drinking levels (38, 47–49).

How Can SNIs Be Improved?

Several aspects might improve the efficacy of SNIs, such as the frequency, the reference group, or the selection of the intervention group. Samson and Tanner-Smith (50) meta-analytically showed that even one single session of PNF might have the same positive impact on alcohol consumption in the short- and medium-term as motivational enhancement therapy, motivational interviewing, or even more elaborated techniques. Most PNF interventions refer to "typical University students" as the normative peer group (43, 51). However, recent research highlights the importance of personal significance of the reference group to the individual. Close reference persons such as friends or peers, as well as factors like specificity (e.g., gender specificity) seem to have a greater impact on individual alcohol consumption than less close or specific reference groups such as "typical University students" (35, 52–54). Furthermore, Haug et al. (55) argue for selective SNI for persons who consume more alcohol than the average, as the intervention was more effective in studies that pre-selected persons with problematic alcohol use [see also (48)].

In summary, research shows that email-based PNF for alcohol prevention and reduction of alcohol consumption is effective among University students. Interventions seem to be most effective when they are personalized, gender-specific, and targeted at University students who drink more alcohol than the average of their peers.

What Should We Do?

While interventions based on social norms are popular and widely applied at US universities, interventions that address University students in Europe and especially Germany are rare (41). SNIs have established themselves in the US as a meaningful way to reduce alcohol consumption. In order to popularize this type of intervention in Germany, the effects of an SNI were tested in this study.

Based on the existing evidence, we expect the effects of our PNF to be two-fold: First, we expect a correction of University students' misperceived behavioral norms with regard to their peers' alcohol consumption. Second, we expect a reduction of alcohol intake on the behavioral level.

The intervention aims to specifically address students who overestimate their peers' alcohol consumption and consume more than the average of their peers. Consequently, our hypotheses are:

Hypothesis 1: The intervention (personalized normative feedback) corrects misperceived behavioral norms in University students who overestimate the alcohol intake of their peers and consume more alcohol than the average of their peers at 12 weeks after the intervention.

Hypothesis 2: The intervention (personalized normative feedback) reduces levels of alcohol intake on the behavioral level in University students who overestimate the alcohol intake of their peers and consume more alcohol than the average of their peers at 12 weeks after the intervention.

MATERIALS AND METHODS

Study Procedure and Sample

Our intervention was part of a general health monitoring survey at a major University in Germany. The survey covered University students' perception of study characteristics, health outcomes as well as their health behavior. All University students enrolled at the University were invited to take part in the survey. The survey was conducted twice (January/February and June/July 2019), with a total of 862 University students (mean age: 24 years;

see **Figure 1**) participating. Two months (6–10 weeks) after the first survey, 563 (65.3%) University students received feedback upon request concerning their own and their peers' alcohol consumption. In the second survey, 432 (76.7%) University students of those who had received feedback indicated that they had actually read the feedback. University Students who had not taken part in the intervention (no feedback requested or not read the feedback) were assigned to the control group. The gender ratio (♀:♂) was 3:1 in each group. All subjects answered the questions on alcohol consumption on both occasions.

Within our a-priori defined subgroup analysis, we included only University students who overestimated their peers' alcohol consumption and who had indicated above average own consumption compared to the median of the peers' consumption. We refer to above average alcohol consumption as "heavy drinking." No randomized assignment to the groups was possible. Consequently, 190 students fulfilling these criteria and were assigned to the intervention group and 101 students that also met these criteria to the control group. Those who did not fulfill inclusion criteria but wanted feedback were also given feedback. Thus, every University student requesting feedback received one.

Measures

To assess University students' individual alcohol intake, we used the Alcohol Use Disorders Identification Test Consumption [AUDIT-C; (56)]. The AUDIT-C consists of three items of the original 10-item AUDIT. Each question (e.g., "How often do you drink an alcoholic beverage e.g., one glass of wine, beer, cocktail, schnapps or liqueur?") is scored from 0 (e.g., "never") to 4 (e.g., "6 or more times a week") points, resulting in a score from 0 to 12. An AUDIT-C score of 0 means that participants never drink alcohol.

We utilized frequency-quantity-indices, combined values containing information about both frequency and quantity of alcohol use, within our analyses. These indices were also applied to assess the department- and gender-specific individually estimated group norm. We first asked University students to evaluate their peers' alcohol intake with regard to frequency ("How often does the majority of all female students in your department drink an alcoholic beverage e.g., one glass of wine, beer, cocktail, schnapps or liqueur?") and quantity ["How many alcoholic beverages does the majority of all female students in your department usually drink per drinking occasion? One alcoholic beverage (standard drink) is a small bottle of beer (0,33l), a small glass of wine or sparkling wine (0,125l) or a double schnapps (4cl)"]. The items were adopted from AUDIT-C for estimation of peers' alcohol frequency and quantity. We then multiplied frequency and quantity and thus obtained the frequency-quantity index for the individually estimated group norm.

We computed another frequency-quantity index indicating the behavioral norm (i.e., median of peers' alcohol frequency multiplied with median of peers' alcohol quantity) and compared them by using a difference value (individually estimated group norm – behavioral norm) for the two frequency-quantity indices. By using the term overestimation, we refer to any difference value > 0 (meaning the individually estimated group norm is larger than the behavioral norm). We utilized frequency-quantity-indices, combined values containing information about both frequency and quantity of alcohol use, within our analyses. These indices were also applied to assess the department- and gender-specific individually estimated group norm. We first asked University students to evaluate their peers' alcohol intake with regard to frequency ("How often does the majority of all female students in your department drink an alcoholic beverage e.g., one glass of wine, beer, cocktail, schnapps or liqueur?") and quantity ["How many alcoholic beverages does the majority of all female students in your department usually drink per drinking occasion? One alcoholic beverage (standard drink) is a small bottle of beer (0,33l), a small glass of wine or sparkling wine (0,125l) or a double schnapps (4cl)"]. The items were adopted from AUDIT-C for estimation of peers' alcohol frequency and quantity. We then multiplied frequency and quantity and thus obtained the frequency-quantity index for the individually estimated group norm.

Personalized Normative Feedback

In 2016, we started the project ISPI ("Internet, Studierende, Peers & Intervention") in cooperation with the Leibniz-Institut für Präventionsforschung und Epidemiologie in Bremen and implemented a first intervention. This 2016 intervention resulted in a change of difference to norms but not a change of behavior regarding the alcohol consumption of University students (57).

With the current intervention, we tried to strengthen and expand the effects of 2016. We further personalized the reference group for the University students by not only specifying it to their gender but also to their study department. With an even smaller comparison group we wanted to reach a higher degree of identification and a stronger effect of the intervention on both group norms and behavior. Additionally, we revised and clarified the normative feedback. We used PNF in the form of e-mails to reach as many University students as possible. One crucial advantage of e-mail-based interventions is that participants can access the information at any time or place whilst also protecting their anonymity (58). SNI with PNF represents a stand-alone, e-mail-based, personalized, normative feedback intervention.

The University students received feedback concerning their own as well as their peers' alcohol intake with regard to frequency and quantity as well as binge drinking behavior (defined as six or more alcoholic drinks per drinking occasion). The feedback consisted of three parts. In the first part, the University students received feedback of what they had indicated with regard to their own alcohol consumption (e.g., "You stated that you consume alcohol 3 to 4 times per week, usually 1 alcoholic drink per drinking occasion." / "You stated that you drink more than 6 alcoholic drinks per drinking occasion once a month."). In the second part, the University students received feedback with regard to their estimated alcohol intake of their peers i.e., the (mis-)perceived group norm (e.g., "You suppose, that the majority of the female students in your department consume alcohol 3–4 times per week, usually 2 alcoholic drinks per drinking occasion."). In the third part, the students received feedback about their peers' alcohol intake (behavioral norm e.g.,

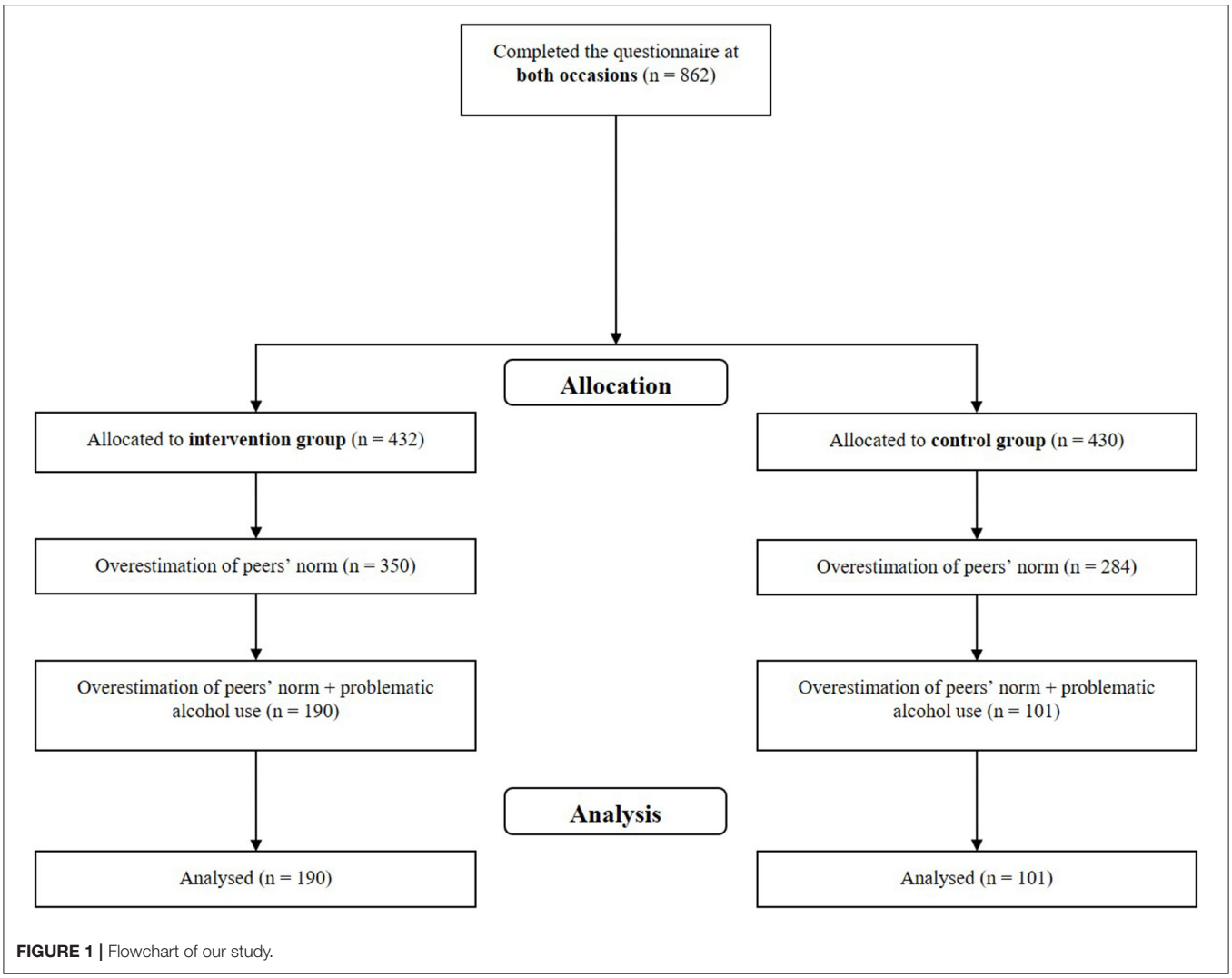

FIGURE 1 | Flowchart of our study.

"In fact, the majority of the female students in your department consume alcohol 1–2 times per week, usually 2 alcoholic drinks per drinking occasion."). Lastly, the University students received a statement indicating whether their alcohol intake was similar or above that of their peers.

Data Analysis

We applied analyses of covariance (ANCOVA) to assess intervention effects with regard to the correction of overestimated group norms as well as University students' drinking behavior. We considered age, sex, self-efficacy and depressive symptoms as covariates. To evaluate the correction of overestimated group norms, we first calculated a frequency-quantity-index for the estimated as well as behavioral norms. Subsequently, we calculated a difference value between the individually estimated group norm (perceived alcohol intake of peers) and the behavioral norm (median, department- and gender-specific). With these indicators, we analyzed the difference values of both occasions for the intervention and control group. Finally, we assessed the changes in intervention and control group drinking behavior by comparing the AUDIT-C scores prior to and after the intervention. We used a 0.05 significance level.

RESULTS

We first identified the gender- and subject-specific behavioral norms for drinking frequency and drinking quantity that were also part of the intervention (feedback). Due to the high number of different behavioral norms that we computed for every gender and subject combination we only constitute the range of behavioral norms for the several combinations: Behavioral norms for quantity varied from 2 drinks to 4.5 drinks and behavioral norms for frequency varied from 1 time per month to 1–2 times per week.

With regard to hypothesis 1—the correction of overestimated individually estimated drinking norms—we observed a significantly larger reduction in the difference value (between the

individually estimated group norm and the behavioral norm) in the intervention group compared to the control group [$F_{(2)} = 8.46$, $p < 0.001$, $\eta_p^2 = 0.06$]. This confirms hypothesis 1, namely that the intervention would correct misperceived individually estimated group norms in the intervention group.

With regard to hypothesis 2—the reduction of alcohol intake—we observed a significant reduction in their AUDIT-C scores [$F_{(2)} = 3.96$, $p = 0.020$; $\eta_p^2 = 0.03$]. Hence, the behavioral outcomes were in line with our hypothesis 2. Corrected means, standard deviations and test statistics of the outcome measures are depicted in **Table 1**.

DISCUSSION

We investigated whether a personalized, gender-specific social norms intervention for University students would affect their perception of their peers' alcohol intake as well as their own drinking behavior. Specifically, we compared the effects in the intervention group with a control group. Since most studies on SNI in University students were conducted in the USA, Australia, Brazil, New Zealand, Sweden, or the United Kingdom (41), our intervention constitutes one of the first studies evaluating SNI in German University students.

Our results are in line with our hypotheses. In contrast to the control group, participants in the intervention group ended up with a more realistic perception of their peers' alcohol intake. However, their perception was still above the group norm. Furthermore, participants of the intervention group reported a significantly larger reduction in the AUDIT-C score, which means that—compared to the control group—they drank less and less often after the intervention. However, their drinking level was still high yet lowered.

Our results confirm prior SNI research that found that University students reported significant decreases of their alcohol intake [e.g., (59, 60)]. There has, however, been serious criticism concerning SNI use with European populations. John and Alwyn (61) argue that there are important differences in campus life and in the definitions of alcohol misuse or heavy drinking between the UK and the US. They consider SNIs to be an ineffective tool in tackling heavy drinking behavior in European populations. Contrastingly, our study was able to validate SNI's efficacy in a European population and thus makes a valuable contribution to the knowledge about SNI.

We decided to use PNF in the form of e-mails to reach as many University students as possible. Since we integrated the intervention into our regular health monitoring survey, we showed that it is possible to implement both, health assessment and intervention simultaneously. This is a very effective and cost-efficient method. Still, there are several other feedback delivery options, in particular web/computer feedback, individual face-to-face feedback, group face-to-face feedback and general social norms marketing campaigns. In some cases, like when the intervention targets specific and small courses, it may be more appropriate to choose another delivery method, e.g., face-to-face feedback. Overall though, (e-)mailed feedback has been identified as one of the best delivery options for SNI (41).

The feedback in our study was department- and gender-specific. We do not know whether the overestimation of the group norms was affected by this choice of reference group. Galesic et al. (23) propose that the overestimation of people's behavior results from judging the behavior of a rather unfamiliar sample. Consequently, assessing the behavior of acquainted others might yield more realistic estimations. However, Giese et al. (25) have disproven this hypothesis. They showed that overestimation still occurs even when the reference group comprises only familiar people.

Not much research exists concerning the content and precise wording of the feedback. When studying the efficacy of a campaign to correct social group norm, Thombs et al. (62) found that only 38.5% of their sample understood the intended purpose of the campaign and its intervention. Therefore, we decided to not only include the participant's own and their peers' alcohol intake in the feedback but to also explicitly state whether the participant's alcohol intake was similar or above that of their peers. We also added whether or not their consumption would be categorized as problematic. We hoped that this information would made the feedback's intention easier to understand.

Furthermore, it is still rather unclear why SNI are more effective for some University students than for others. Giese et al. (25) have shown that University students with high self-control make more realistic estimations of their peers' alcohol consumption. There may be several other individual characteristics that impact the efficacy of SNI. We need much more knowledge on why University students overestimate peers' alcohol intake, and which University students are most vulnerable to such an overestimation, in order to target SNI most effectively. Other SNI studies suggest that several other contextual factors may influence its efficacy, e.g., social and environmental factors [availability of alcohol, acceptance of alcohol consumption in public; (63)]. Future research could also operationalize and control these social and environmental factors.

Limitations

Our intervention is not free of shortcomings.

First, we used the AUDIT-C as an efficient, reliable and valid measure to assess the alcohol intake of the participants as well as the alcohol intake of their peers. The AUDIT-C has been successfully applied in previous SNIs (41). However, more direct behavioral measures such as the Alcohol Timeline Followback [TLFB; (64)] might be better suited to examining alcohol consumption and thus the effects of the intervention.

Second, a larger sample size might have improved and expanded our results. Since we included the intervention in our regular health monitoring survey, only 190 University students met our inclusion criteria for the intervention that we formulated a-priori (University students who overestimated their peers' alcohol use and indicated above average own consumption compared to peers' median alcohol use). Most of the studies on SNI targeted University students with increased risk (41), however, it may also be important to consider the intervention as a prevention tool for those who are not (yet) at increased risk or even at low-risk University students [e.g., (65)]. Furthermore,

TABLE 1 | Corrected Means and test statistics of the ANCOVA outcome measures.

	IG	CG	IG	CG				
	T1		T2					
	M (SE)	M (SE)	M (SE)	M (SE)	F ratio	*df*	*p*	η_p^2
Difference value (individually estimated group norm – behavioral norm)	17.85 (1.32)	18.73 (1.77)	7.828 (1.00)	17.41 (1.34)	8.46***	2	<0.001	0.06
AUDIT-C score	4.92 (1.58)	5.20 (1.74)	4.31 (0.12)	4.94 (0.16)	3.96*	2	0.020	0.03

*Corrected means for the AUDIT-C score (sum of the three AUDIT-C items) and the difference value between individually estimated group norm (as a frequency-quantity index of the estimation) and the behavioral norm (also as a frequency-quantity index). Covariates (age, sex, self-efficacy, and depressive symptoms) were considered. IG, Intervention group; CG, Control group; *p < 0.05; ***p < 0.001. T1: $N_{IG} = 95$ and $N_{CG} = 179$; T2: $N_{IG} = 92$, and $N_{CG} = 180$.*

almost 75% of the participants were female, which also limits the generalizability of our results.

Third, we promised all interested University students who participated in our health monitoring survey a detailed feedback on their and their peers' alcohol intake, regardless of whether their intake was above the group norm. Hence, we did not randomly assign survey participants to either intervention or control group. A randomized assignment did not seem ethically justifiable as this would mean withholding the intervention from the control group or at least postponing their intervention. However, this selection procedure involves several shortcomings, especially the limited comparability between intervention and control group. Thus, we cannot rule out potential selection biases as would be possible with randomized control trials (RCT). RCTs randomly assign participants to either intervention or control group. Thus, RCTs are more comparative, minimize several biases (e.g., allocation or selection bias) and also minimize confounding factors. Since RCTs are the gold standard in interventional research, future studies should preferably use this design. Nevertheless, our design allowed us to control for known confounders and we therefore used sex, age, self-efficacy, and depressive symptoms as covariates within the ANCOVAs.

Fourth, although we asked participants if they received the intervention, we cannot be sure whether all of them read their feedback carefully and attentively. As described above, feedback of earlier studies was sometimes not clear enough, so we tried to keep the feedback as easy and understandable as possible. We are certain that the majority of University students was able to interpret it correctly.

Fifth, we used the second survey of our health monitoring to capture the effects of the intervention. This second survey was 12–16 weeks after the intervention. Unfortunately, we were not able to evaluate any long-term effects (e.g., after 1 year).

Sixth, we were able to observe significant differences in difference to norm (individually estimated group norm – group norm), AUDIT-C score. These effects were rather small in terms of effect sizes. However, in line with the prevention paradox, even small effect sizes can make a difference in such interventions.

Conclusion

Our study proves SNI's overall efficacy in both norm and behavioral outcome variables. It is one of the first studies applying SNI in a German student sample. Since we focused on University students with overestimation of the group norm and an above average alcohol intake, we examined SNI's effect not only on University students with harmful alcohol consumption. Our intervention successfully addressed alcohol intake in University students with above average alcohol use. Therefore, SNI can also be used as a primary preventive instrument reducing alcohol use not only in those with problematic alcohol use.

Our study furthermore shows that it is possible to integrate SNI into regular health monitoring. This is an effective, cost-efficient, and pragmatic way to combine both, screening and intervention of alcohol misuse in University students. Along with environmental interventions and possible restrictions of alcohol promotion, SNI may be one important piece in the prevention of health problems due to alcohol misuse (59).

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics committee Freie Universität Berlin; FB Erziehungswissenschaft & Psychologie. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CW, TL, and BG: conceptualization, investigation, validation, data curation, and project administration. CW, TL, BG, and TT: methodology. CW: formal analysis. CW, TL, BG, and A-CH: writing—original draft preparation. TL, CW, BG, A-CH, and TT: writing—review and editing. TL and CW: visualization. BG: supervision. All authors contributed to the article and approved the submitted version.

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Perceptions of Study Conditions and Depressive Symptoms During the COVID-19 Pandemic Among University Students in Germany: Results of the International COVID-19 Student Well-Being Study

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Background: Results of previous studies examining the impact of the SARS-CoV-1 epidemic in 2003 on university students' mental well-being indicated severe mental health consequences. It is unclear how the current COVID-19 pandemic and the changes in study conditions due to federal regulations affected mental well-being in the German student population. We examined university students' perceptions of study conditions during the COVID-19 pandemic and investigated associations between study conditions and depressive symptoms.

Methods: A cross-sectional online survey was conducted in Germany in May 2020 at four universities (N = 5,021, 69% female, mean age: 24 years, SD: 5.1). Perceived study conditions, as well as sociodemographic information, were assessed with self-generated items and the CES-D 8 scale was used to determine depressive symptoms. Associations between perceived study conditions (academic stress and academic satisfaction), in general, and confidence to complete the semester, in particular, and depressive symptoms were analyzed using generalized linear regressions.

Results: Fifty-four percent of survey participants felt that the university workload had significantly increased since the COVID-19 pandemic; 48% were worried that they would not be able to successfully complete the academic year; 47% agreed that the change in teaching methods caused significant stress. Regarding depressive symptoms, the mean score of the CES-D 8 scale was 9.25. Further, a positive association between perceived study conditions and depressive symptoms was found ($p < 0.001$), indicating that better study conditions were associated with fewer depressive symptoms. Results of the generalized linear regression suggest that better student mental well-being was related to higher confidence in completing the semester.

Conclusions: This study provides first insights into perceived study conditions and associations with depressive symptoms among students during the COVID-19 pandemic in Germany. Findings underline the need for universities to provide intervention strategies targeting students' mental well-being during the course of the pandemic.

Keywords: study conditions, university students, COVID-19, mental health, pandemic

INTRODUCTION

According to the Robert-Koch Institute (RKI), to date, in Germany, there are 2,434,446 confirmed cases of COVID-19 as of February 27th, 2021 (1). The necessary measures that were taken in order to minimize the spreading of COVID-19 affected the entire German society and many aspects of daily lives of German citizens. In mid-March 2020, universities were closed and lectures and courses were predominantly held online. New formats had to develop *ad hoc* by teaching staff because they had not been implemented in most universities prior to the outbreak (2).

It is known from previous research examining the consequences of epidemics on physical and psychological health that an epidemic outbreak seriously impacts on health (of those afflicted with the disease and those avoiding infection). Past epidemics, including SARS-CoV-1 that occurred in China in 2003, Ebola in 2014 in West Africa, and MERS in 2015, had a severe negative impact on individuals' mental well-being. Existing literature on the impact of the COVID-19 pandemic suggests that there is the potential of drastic psychological consequences in the general population, including University students (e.g., increases in the prevalence of depression and anxiety) (3). Taking into consideration that COVID-19 compared to e.g., the SARS-CoV-1-epidemic is a more infectious virus and more threatening to a larger part of the population and the fact that more people were in self-isolation or lockdowns, similar psychological consequences, as a result of the ongoing COVID-19 pandemic, are conceivable at the population level.

A large body of evidence indicates that college and University students are generally vulnerable to mental health disorders due to academic stressors, such as the pressure to succeed, uncertainty of plans after graduation, and financial worries experienced while studying (4–6). Previous research suggests that University students are more likely to develop general anxiety disorder or depression (7) or even suicidal thoughts and behaviors (8) when compared to individuals in the same age bracket but not enrolled in tertiary education. The fact that universities were closed and students had to get used to online education which was previously not part of most University culture may have increased students' concerns about not being able to successfully complete the academic year, accompanied by a negative impact on their mental well-being (9). Also, as everyday social interactions with fellow students in the University setting were no longer taking place, social isolation may have impacted on mental well-being. This situation may have also exacerbated existing psychological symptoms and the impact of stressors evident prior to the outbreak (10). While no investigations focusing on this particular population have yet been published, there have been reports on the psychological impact of the COVID-19 pandemic on young adults, indicating that younger individuals (aged <35 years) reported a higher prevalence of general anxiety disorder and depressive symptoms compared to older individuals (aged >35 years) (11). Further, previous research suggests that academic stress and poor academic satisfaction can be consequences of difficult study conditions (12). In our paper, the constructs of academic stress and academic satisfaction were combined as an indicator for study conditions (13).

Hence, to investigate possible consequences of the shift in study conditions during the first COVID-19 outbreak in March 2020 in Germany, we investigated perceptions of study conditions and depressive symptoms among University students in a cross-sectional study. This study aimed to elucidate possible associations of (changed) study conditions and the accompanying confidence to complete the semester with depressive symptoms among University students in various geographical regions of Germany using data from the International COVID-19 Student Well-being Study (C19 ISWS).

MATERIALS AND METHODS

Study Design—The International COVID-19 Student Well-Being Study

This study is part of the C19 ISWS, examining the impact of the COVID-19 pandemic on student well-being at 110 higher education institutions in 27 European and North-American countries, as well as in South Africa. It is led and coordinated by a research team at the University of Antwerp in Belgium (UAntwerp, principal investigators: Sarah Van de Velde, Veerle Buffel, and Edwin Wouters). The study protocol outlining the aims and methods employed in the study can be found elsewhere (13).

The original version of the questionnaire was developed and distributed (in English) by the UAntwerp research team and two authors of the German team (SMH, HB) translated it into German. The UAntwerp research team inserted the translated questions into the Qualtrics software. Data collection using the online Qualtrics survey was carried out for 2 weeks (from May 12th to 29th, 2020) at each participating German University. In the online survey, sociodemographic information, perceived study conditions, financial resources, health behavior, living situation before and during COVID-19 outbreak, COVID-19 diagnosis and symptoms, perceived worries, critical health literacy and knowledge about COVID-19, and mental well-being were assessed. The core questionnaire used can be found elsewhere (14).

Recruitment at the German Study Sites and Participation

As part of the larger C19 ISWS, the online survey was conducted at four German universities in May 2020; participants included 5,021 students, approximately two-thirds of the sample came from the University of Bremen and the University of Siegen and the other third constituted students from the Charité—Universitätsmedizin Berlin and the Heinrich Heine University Duesseldorf (15). Students were predominantly invited to participate in the study via email and on the universities' homepages, as well as e-learning platforms. Invitations were also distributed via social media channels, such as Instagram or Facebook channels.

In May 2020, all the universities named above were closed in order to reduce the spreading of COVID-19. Most teaching was performed online. On-campus activities, such as campus sports, were prohibited and University canteens, cafés, and libraries were also closed at the time of data collection.

All participants provided their consent to participate prior to completing the survey. An informed consent page containing the research objectives, information on data security, subjects' privacy, confidentiality, non-material incentive, and the contact details of the researcher, preceded the survey. Participation in the survey was voluntary, and individuals could withdraw at any time during the survey by closing the web browser.

Ethical approval for conducting the study was obtained at the Ethics Committees of the four participating universities.

Measures

Perceived Study Conditions

In this article, two self-constructed scales which were based on factor analysis were used to assess perceived study conditions; one measuring academic stress and the other academic satisfaction (16). Students were asked to indicate to what extent they agreed with the following eight statements:

(1) "My university/college workload has significantly increased since the COVID-19 outbreak;" (2) "I know less about what is expected of me in the different course modules/units since the COVID-19 outbreak;" (3) "I am concerned that I will not be able to successfully complete the academic year due to the COVID-19 outbreak;" (4) "The university/college provides poorer quality of education during the COVID-19 outbreak as before;" (5) "The change in teaching methods resulting from the COVID-19 outbreak has caused me significant stress;" (6) "The university/college has sufficiently informed me about the changes that were implemented due to the COVID-19 outbreak;" (7) "I am satisfied with the way my university/college has implemented protective measures concerning the COVID-19 outbreak;" (8) "I feel I can talk to a member of the university/college staff (e.g., professor, student counselor) about my concerns due to the COVID-19 outbreak." Response categories forming a 5-point Likert scale ranged from strongly agree to strongly disagree. The perceived study conditions were assessed as a sum of the ratings, with reverse coding of the positive items, so that a higher score of study conditions indicates higher academic stress and dissatisfaction and a lower score lower stress and higher satisfaction. The score was used as a continuous variable.

To assess the frequency of contact with teaching staff, students were asked the following question: "In comparison to the period before the COVID-19 outbreak, did you seek more or less contact with the teaching staff at your university/college:" (a) to discuss worries about studies, (b) to discuss psychosocial problems. Response options ranged from much less to much more on a 5-point Likert scale. We combined the categories "much less" with "less" and "more" with "much more."

To assess the contact with student-counseling and social services, students were asked "Since the COVID-19 outbreak, did you seek contact with student-counseling services or social services at your university/college?" (response options: yes/no). The following reasons could be named for contacting counseling services (multiple choice): worries about studies; financial worries/difficulties; psychosocial problems; other worries; prefer not to say.

Subjective Depressive Symptoms

Subjective depressive symptoms were assessed using the Center for Epidemiological Studies Depression Scale (CES-D 8 scale) (17, 18). The eight items of the CES-D 8 tracked whether students felt depressed and that everything was an effort, had restless sleep, could not get going, felt lonely, or sad or enjoyed life and felt happy (the last two items are reverse-coded). Students were asked to indicate how much of the time during the past week the symptoms listed above applied to them on a 4-point Likert scale [(0) none or almost none of the time; (1) some of the time; (2) most of the time; (3) all or almost all of the time]. Responses to the individual items were summed up to create the overall CES-D 8 score. The score can range from 0 to 24, a higher score suggesting higher levels of depressive symptoms.

Covariates

The following information on the socio-demographic characteristics of students was provided: age, gender (female/male/diverse), relationship status ("single"/"in a relationship"/"it is complicated"), resident status in Germany (permanent residency/temporary residency), availability of a person to discuss intimate matters with (yes/no) were collected.

In regard to their study program, students were asked which study program they were enrolled in [Bachelor program/Master Program/Doctoral Program/State Examination (Medicine, Law)/other].

The following information was provided regarding the living situation: Students were asked where they mainly lived during the COVID-19 outbreak (excluding weekends and holidays). The response options were: with parents/student hall/accommodation with others/accommodation alone and other.

Concerning their financial situation, students were asked to indicate whether they had sufficient financial resources to cover their monthly expenses or not during the COVID-19 outbreak.

Data Analysis

Descriptive statistics were calculated to summarize the sample, regarding the sociodemographic data and study related information. Absolute (*n*) and relative (%) frequencies were determined for perceived study conditions (academic stress

and academic satisfaction) and subjective depressive symptoms during the COVID-19 outbreak using univariate analysis. The frequencies of contact with teaching staff and with student counseling and social services and reasons for getting in touch with these services were descriptively analyzed. Generalized linear regression analyses were conducted to identify the associations between the dependent variable depressive symptoms and the independent variables. Perceived study conditions (academic stress and academic satisfaction), age, gender, program enrolled in, relationship status, living situation, availability of a person to discuss intimate matters with, financial resources, resident status, and study site were included as independent variables in the model. In order to assess confidence in being able to complete the semester, an additional analysis was performed using one item of the academic stress scale (able to successfully complete the academic year due to the COVID-19 outbreak). The association of the confidence to complete the semester and depressive symptoms was examined with a generalized linear regression using the same covariates listed above.

Data analysis was performed using IBM® SPSS® version 26 and SAS Version 9.4 (SAS Institute, Cary, NC, USA).

RESULTS

A total of 5,021 students completed the online survey: 69.4% were female and 29.4% male and the mean age was 24 years ($SD = 5.1$; Min = 17; Max = 50). A total of 53.8% of students were enrolled in a Bachelor program. One-third of the students were living with their parents at the time of data collection. The study sample is described in further detail in **Table 1**.

No significant differences in study conditions (and perceived depressive symptoms) by gender were found in this study. In the following sections, results are therefore reported combining the data for men, women, and diverse students.

Regarding the subjective depressive symptoms during the COVID-19 pandemic, approximately 31% of participants felt frustrated with things, in general. Thirty-one percent of students felt isolated from others. One in four students stated that they felt depressed all or almost all/most of the time during the COVID-19 outbreak. The mean score on the CES-D 8 scale was 9.25 (**Table 2**).

In **Table 3**, results regarding students' perceived study conditions are displayed. Around half of students felt that the university/college workload had significantly increased since the COVID-19 outbreak. Fifty-four percent stated they knew much less what was expected of them in the different courses/units; 47.9% were worried that they would not be able to successfully complete the academic year; 47.2% agreed that the change in teaching methods caused them significant stress.

Table 4 shows students' contact to teaching staff and student counseling or social services at their University. Respondents who generally sought contact with teaching staff to discuss worries about studies or psychosocial problems reported that they had less done so in comparison to the time before the outbreak. Merely 5% of study participants sought contact with student counseling or social services at University. They predominantly used the services to discuss worries about their studies.

The multiple regression model, adjusted for the selected covariates, revealed that higher academic stress was associated with a higher score on the CES-D 8 scale ($p < 0.0001$). Living with parents or living in an accommodation with other people was associated with lower levels of symptoms of depression, as well as having sufficient financial resources. Moreover, University students in a steady relationship (compared to being single) and those indicating the presence of a person to discuss personal matters with (compared to not having such a person in their lives) also more likely to report lower symptoms of depression. No differences in depressive symptoms were observed by the program students were enrolled in or by age (**Table 5**).

TABLE 1 | Sociodemographic and study related characteristics of participants.

	n	%
AGE		
17–19	369	7.3
20–23	2,340	46.6
24–27	1,396	27.8
27–30	454	90
>30	462	9.2
GENDER		
Male	1,478	29.4
Female	3,485	69.4
Diverse	58	1.2
STUDY PROGRAM		
Bachelor program	2,700	53.8
Master program	1,138	22.7
Doctoral program	234	4.7
State examination (Medicine, Law)	910	18.1
Other	39	0.8
RELATIONSHIP STATUS		
In a steady relationship	2,677	53.3
Single	2,149	42.8
It is complicated	195	3.9
LIVING SITUATION		
With parents	1,973	33.3
Student hall	284	4.8
Accommodation with others	2,067	24.9
Accommodation alone	611	10.3
Other	115	1.9
PERSON TO DISCUSS INTIMATE MATTERS WITH		
Yes	4,478	90.4
No	474	9.4
FINANCIAL RESOURCES		
Sufficient to cover monthly costs	4,277	85.2
Not sufficient to cover monthly costs	744	14.8
STATUS IN GERMANY		
Permanent residency	4,725	94.1
Temporary residency	296	5.9

TABLE 2 | Description of subjective depressive symptoms during the outbreak of COVID-19 ($n = 4,933$).

Items of CES-D 8 scale	All or almost all/most of the time		Some of the time		Almost none or none of the time	
	n	%	*n*	%	*n*	%
Felt depressed	1,240	24.7	2,541	50.6	1,152	22.9
Felt that everything they did was an effort	1,489	29.7	2,046	40.7	1,398	27.8
Sleep was restless	1,447	28.6	2,064	41.1	1,422	28.3
Happy	2,540	50.6	2,060	41.0	333	6.6
Felt lonely	994	19.8	1,916	38.2	2,023	40.3
Enjoyed life	2,105	42.0	2,177	43.4	651	13
Felt sad	920	18.3	2,683	53.4	1,330	26.5
Could not get going	1,440	28.7	2,033	40.5	1,460	29.1
		Mean	**95% CI**	**SD**		
CES-D 8 Scale		9.25	9.11–9.38	0.67		

CI, confidence interval; SD, standard deviation.

TABLE 3 | Perceived study conditions among University students ($n = 4,903$).

	Strongly agree/Agree		Neither agree nor disagree		Disagree/Strongly disagree	
	n	%	*n*	%	*n*	%
University/college workload significantly increased	2,741	54.6	1,073	21.4	1,089	21.8
Knowing less about what is expected of me in the different course modules/units	2,713	54.1	958	19.1	1,232	24.5
Concerned about not being able to successfully complete the academic year	2,409	47.9	701	14.0	1,793	35.7
University/college provides poorer quality of education	1,756	35.0	1,455	29	1,692	33.7
Change in teaching methods caused significant stress	2,371	47.2	928	18.5	1,604	31.9
University/college provided sufficient information about the implemented changes	3,515	70.0	656	13.1	732	15.4
Satisfied with the implemented protective measures taken by University	3,341	66.5	932	18.6	630	12.6
Feel that one can talk to a member of the university/college staff (e.g., professor, student counselor)	1,591	31.7	1,962	39.1	1,350	26.9

TABLE 4 | Frequency of contact with teaching staff and contact with student-counseling services or social services and reasons for contact (multiple choice).

	Much less/Less		Similar		More/Much more	
	n	%	*n*	%	*n*	%
Contact with teaching staff to discuss worries about studies ($n = 2,196$)	1,020	46.4	699	31.8	477	21.7
Contact with teaching staff to discuss psychosocial problems ($n = 1,174$)	565	48.1	514	43.8	95	8.1
		Yes			**No**	
	n		%	*n*		%
Contact with student-counseling services or social services ($n = 4,928$)	251		5.1	4,677		94.9
Reasons for contact with student-counseling services or social services	*n*		%			
Worries about studies	127		50.6			
Financial worries/difficulties	46		18.3			
Psychosocial problems	6		2.4			
Other worries	71		28.3			
Prefer not to say	31		12.4			

TABLE 5 | Effect estimates of the generalized linear model of study conditions on depressive symptoms.

Variable	Regression on depressive symptoms score	
	Regression coefficient[a] (*SD*)	*p*-Value
Intercept	7.81 (1.09)	<0.0001
Study conditions	0.25 (0.01)	<0.0001
Age	0.00 (0.01)	0.8208
Gender		
Female	0.00 (0)	*Reference*
Male	−1.03 (0.14)	<0.0001
Diverse	2.31 (0.58)	<0.0001
Study program		
Bachelor programme	0.00 (0)	*Reference*
Master programme	0.21 (0.72)	0.7680
Doctoral programme	−0.12 (0.72)	0.8692
State examination (Medicine, Law)	−0.29 (0.76)	0.6998
Other	−0.40 (0.72)	0.5748
Relationship status		
In a steady relationship	−0.70 (0.14)	<0.0001
Single	0.00 (0)	*Reference*
It's complicated	0.93 (0.32)	0.0037
Living situation		
With parents	−0.90 (0.21)	<0.0001
Student hall	−0.41 (0.32)	0.1979
Accommodation with others	−0.76 (0.20)	0.0002
Accommodation alone	0.00 (0)	*Reference*
Other	−0.81 (0.44)	0.0659
Person to discuss intimate matters with		
Yes	−3.18 (0.21)	<0.0001
No	0.00 (0)	*Reference*
Financial resources		
Sufficient to cover monthly costs	−2.02 (0.18)	<0.0001
Not sufficient to cover monthly costs	0.00 (0)	*Reference*
Status in Germany		
Permanent residency	0.00 (0)	*Reference*
Temporary residency	0.35 (0.28)	0.2060

[a]*Adjusted for age, gender, study program, relationship status, living situation, person to discuss intimate matters with, financial resources, residency status, study site.*

The regression model analysing confidence in being able to complete the semester and depressive symptoms yielded a higher regression coefficient for the CES-D 8 score, the more concerned students were about being able to complete the semester. Conversely, the more confident students were in being able to complete the semester, the better their depressive symptoms (**Table 6**).

TABLE 6 | Effect estimates of the generalized linear regression model of confidence in completing the semester on depressive symptoms.

Variable	Regression on depressive symptoms score	
	Regression coefficient[a] (*SD*)	*p*-Value
Intercept	12.34 (1.03)	<0.0001
Able to successfully complete the academic year due to the COVID-19 outbreak		
Strongly agree	4.46 (0.21)	<0.0001
Agree	2.68 (0.20)	<0.0001
Neither agree nor disagree	2.11 (0.22)	<0.0001
Disagree	1.12 (0.20)	<0.0001
Strongly disagree	0.00 (0)	*Reference*

[a]*Adjusted for age, gender, study program, relationship status, living situation, person to discuss intimate matters with, financial resources, residency status, study site.*

DISCUSSION

This paper investigated perceptions of study conditions during the first COVID-19 outbreak and the associations with students' depressive symptoms. We found that approximately half of the students felt burdened by an increased workload and felt worried about being able to successfully complete the academic year. Both of these factors are indicators for an increase in students' academic stress. Further, our results suggest that higher academic stress and dissatisfaction were associated with higher levels of depressive symptoms.

Depressive Symptoms

The high level of depressive symptoms among University students, which we found in our study (CES-D 8 means 9.25), was similar to the findings among Belgian higher education students (CES-D 8 means 10.8) (16). Also, Li et al. reported an increase in negative affect and symptoms of anxiety and depression since the COVID-19 outbreak among University students due to the restrictions in the University context (19). Another study that investigated the psychological impact of COVID-19 in Chinese University students reported an increase of symptoms of anxiety among students (20). Further, a study conducted at a University in the United States of America found alarming results concerning students' mental health enrolled in higher education under COVID-19 conditions (21). They found an increase of anxiety and stress due to the COVID-19 outbreak for the majority of the students who completed the survey (71%). This study identified various stressors similar to the ones assessed in our study contributing to increased levels of stress (21).

Study Conditions and Mental Well-Being

COVID-19 and its various consequences have an impact and will continue impacting on University students' mental health and well-being (22) and the study conditions are just one of many factors that have changed for students since the COVID-19 outbreak. Previous studies showed that worrying about academic performance is a stressor among University students (21). This leads to an increase of academic stress and it is known from previous literature that academic stress is associated with depression and anxiety (4). Accordingly, high levels of academic stress (academic expectations, faculty work and examinations, students' academic self-perceptions) were reported by Italian University students during the COVID-19 outbreak in a study (9) that also found a negative correlation between academic stress and mental well-being during the pandemic.

Contact With Student's Services and Students' Confidence

Our results indicate that students rather sought less contact to teaching staff than before the COVID-19 outbreak and very few had contact to student counseling services. Many students felt that, since the outbreak, their workload for University had increased, as well as their fear of not being able to successfully finish the semester. Furthermore, the results of our study indicate that the higher students' confidence to complete the semester, the better their depressive symptoms. This is plausible as students experienced delays in their academic progress and possibly an impact on future employment due to the COVID-related restrictions (23).

Social Distance and Social Support

Previous research demonstrated the negative impact of quarantine on students' mental health (24). Quarantine was identified as a stressor among Pakistani medical students reporting that they felt emotionally detached from their families and friends (24). Also, evidence suggests that social distancing affected the mental well-being of students negatively (25). This is in line with our finding that living together with other people is associated with better mental well-being. In a stressful situation, such as the COVID-19 pandemic, social support plays an important role for maintaining mental well-being and reliable people can help maintain mental well-being (26, 27). Social support can come in various forms (28) and having someone to discuss personal matters with or living with parents could be protective factors against the development of psychological problems. Even in times of social distancing, promoting alternatives for this in-person support and exchange may help reduce stress and improve students' mental well-being.

The results of our study call for several actions, which should be undertaken by universities to minimize harm on the part of students. Universities should provide easily accessible student counseling and social services, as well as mental health care services. Moreover, continuous evaluation of students' perceptions of study conditions are needed to adjust information flow and academic practices to student's needs. Because this global pandemic has led to a global mental health crisis (29), universities should be aware of the increased risk of mental health problems among their student body, especially taking into consideration that the global student population was already considered a group vulnerable to mental illness prior to the outbreak (30). Building institutional and societal awareness of students' needs for mental health care is important in order to support them (22). Hence, universities should provide timely and appropriate mental health care to students in the future. The findings of the recent studies show the urgent need to develop interventions and preventive strategies to address the mental health of college students in the current situation (21). Therefore, universities should develop strategies to identify and support students at higher risk for negative psychological consequences during the COVID-19 pandemic (31). Digital mental health care can be an alternative to support students and improve their mental well-being, especially, in situations where in-person counseling is provided due to COVID-19-related restrictions (32, 33). Training for faculty preparing them for shifts to online teaching is necessary in this process as well (34). As much of the students' perceived stress came from the insecurity of the educational situation, universities can reduce stress by ensuring smoother transitions in the future.

Some limitations need to be addressed. In the International COVID-19 Student Well-being Study, depressive symptoms were assessed with a shortened version of the validated CES-D scale, first validated in a sample of older adults (35). The perceived study conditions refer to the time since the outbreak only. Therefore, we could not investigate how students perceived the study conditions before the outbreak in comparison to the time during the pandemic. A study conducted in October 2017 to March 2018 in Germany, in a not representative sample, found that perceived academic stress explained a great amount of distress symptoms among University students (36). In addition, the study compares the pandemic study conditions in some of the items with time before the outbreak, but, unfortunately, depressive symptoms were only recorded for the time during the outbreak. Another study among University students in Germany compared the impact of lockdown stress and loneliness during the COVID-19 pandemic on mental health and found a higher level of depressive symptoms during than before the pandemic (38.5 vs. 27.7%) (37). Our results suggest that approximately one-half of the assessed student population felt that study conditions had worsened during the COVID-19 outbreak and that this might have had a negative impact on their mental well-being. However, the results are limited due to the cross-sectional design of the study and the causality of the findings remain unclear. Longitudinal studies are necessary to examine the impact of changed study conditions on mental well-being in the long-run. Furthermore, the response rate was limited to approximately 10% and selection bias cannot be ruled out.

To conclude, this study provides first insights into associations between perceived study conditions and depressive symptoms among University students during the COVID-19 pandemic in Germany. Additional research is necessary to examine mental well-being of students under pandemic conditions in the long-term and to evaluate whether strategies developed by universities to help students cope with the situation are successful or not.

DATA AVAILABILITY STATEMENT

Due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data are not publicly available. Data are available on request from the corresponding author for collaborating researchers within the C19 ISWS consortium, as consent for this was provided from all participants.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of all four participating universities (Charité—Universitätsmedizin Berlin, University of

Bremen (protocol code 2020-04-EILV, dated 4 May 2020), Heinrich-Heine University Duesseldorf (protocol code 2020-958, dated 5 May 2020) and the University of Siegen (protocol code ER 08/2020, dated 7 May 2020). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

PMMF, FS, and CRP developed the study questions for this investigation. PMMF, FS, and LK conducted the statistical analyses and wrote the first draft of the article. All authors were involved in the conception and implementation of the German survey and critically revised the content of the article. All authors contributed to the article and approved the submitted version.

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Challenge Accepted! a Critical Reflection on How to Perform a Health Survey Among University Students—An Example of the Healthy Campus Mainz Project

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Background: Universities represent an important setting of everyday life for health promotion. The *Healthy Campus Mainz* project aims to develop an evidence-based and comprehensive student health management program covering physical, mental, and social health promotion. Hence, an initial health survey was performed in order to identify the students' health concerns and resources. Up until now, it remains unclear which topics to choose in a health survey among university students and which strategies can be recommended to receive an acceptable response rate or representative student sample within a university setting. The present paper contributes to the call for the present research topic "Public Health Promotion in University Students" by describing methods for health assessment. Therefore, the current paper aims to give an empirical example on how to perform a health survey among university students, focusing on (1) choosing topics for the survey and (2) methodological considerations of how to reach the target population.

Methods: An online questionnaire including around 270 items was developed covering a comprehensive set of health topics. Participants were recruited via the university email. Mixed channels for survey promotion, such as lecture visits and social media, were used, accompanied by different monetary and non-monetary incentives. Descriptive analyses were performed to describe the sample.

Results: A total of 5,006 participants (out of 31,213 registered students) viewed the first page of the questionnaire; of whom, 4,714 continued further. After a manual data cleaning according to the predefined criteria, the final sample was 4,351, demonstrating a response rate of 13.9%. Students from different study disciplines participated. However, some study disciplines showed a low participation rate, hence, making the results not free from some bias.

Discussion: This survey is exceptional as it integrates a great variety of health aspects. The incentive strategy demonstrated promising results. Future research should try to improve target-group-specific recruitment strategies for the traditionally underrepresented groups, such as males and specific study disciplines. This would not only include advancing marketing strategies, but also refining the incentive strategy.

Keywords: health survey, student health, health promoting university, health promotion, university students

INTRODUCTION

According to the World Health Organization, health is not just a state but, rather, "a resource for everyday life" (1). It is created and lived by people within the settings of their everyday life, where they learn, work, play, and love (1), underlining the interconnectedness between individuals and their environments. In the *Okanagan Charter* of 2015, an international expert group emphasized that universities are important settings of people's everyday life for health promotion (2). They further claimed that the collective population of university students would be particularly relevant from a public health point of view. They argued that health promotion in university students would not only be favorable for the health of the target population, but since university students are the decision-makers, leaders, and also parents of tomorrow, health promotion may also benefit the society as a whole (2). The high societal relevance of health promotion for different settings can also be seen in the recent developments in the legislations. In 2015, the German Government passed the so called "*prevention law*," aiming to support health promotion and prevention in different settings of everyday life (3). Accordingly, the statutory health insurances have to spend a set amount of money (around 7€) for each insurant for health promotion and prevention projects in different settings of everyday life.

Supported with financial resources of a statutory health insurance in the framework of the prevention law, the *Healthy Campus Mainz* project was initiated in 2018. It is an interdisciplinary research project, aiming to create, implement, and evaluate an evidence-based, sustainable, and holistic student health management program for ∼32,000 students at the University of Mainz. This interdisciplinary approach is essential in order to cover a great variety of aspects about student health. The project, therefore, includes experts from the following disciplines: occupational, social, and environmental medicine; work, organizational, and business psychology; psychosomatic medicine and psychotherapy; media science; and sports medicine.

A crucial part of developing an evidence-based health management program tailored to the needs of the local students is to perform a health survey among students in order to specify areas of interest and identify potential risk groups for poor health within the target population. The identification of risk groups can be based on study-related aspects such as field of study, time studying at a university (4), or individual differences in psychosocial personal factors such as personality, behavioral habits, or socioeconomic status. Such information may enable the stakeholders of student health management programs to understand the distinctive needs of its own students, tailor health promotion interventions, and develop policies accordingly. Also, Baik et al. (5) already pointed out how important it is to involve students in the design and implementation of such health programs as this underscores that they are the "experts" of their own needs. Looking at the reports on surveys addressing the university students' health, Kunttu et al. (6) conducted a students' health survey for Finland, Holt and Powell (4) in the UK, and Wörfel et al. (7) in Germany. Kunttu et al. (6) performed an online national survey among Finnish university students (n = 1,829) with 126 questions including a broad set of topics regarding physical, mental, and social health. The purpose of their survey was to map the university students' wellbeing, study ability, and health issues. The 60-item online survey by Holt and Powell was developed to examine the health behaviors and health needs of students (n = 3,683) at a UK urban University with a focus on seven key topic areas (4). These topic areas were chosen based on national and local priorities. Under the umbrella of the *University Health Report* project in Germany, a health survey was developed that can be used and adapted by any other university aiming for health assessment of their students (8). The latest published report, for example, performed at two German universities (n = 1,707) assessed the "strains, resources, health indicators, health behavior, and health risks" as part of a periodical health monitoring (7).

The variety of covered topics in the previous studies, however, is still expandable. Moreover, there is no sufficient consensus on what topics should be included. Seemingly, it also remains unclear which strategies can be recommended to receive an acceptable response rate or representative student sample within a university setting. The present paper contributes to the call for the present research topic, "Public Health Promotion in University Students," by describing methods for health assessment. Therefore, the current paper seeks to answer the following questions:

1. Survey content: Which relevant topics should be included in a health survey among university students?
2. Methodological Considerations: How can the target group of university students be reached in order to gain a large and representative sample?
   - 2.1 Survey method
   - 2.2 Questionnaire design
   - 2.3 Recruitment and survey promotion
   - 2.4 Incentive strategy

As many universities face similar challenges, the present paper aims to address the above-mentioned questions and to provide an example on how to perform an effective health survey among university students. These suggestions are based on our experience, and are meant to provide a platform for discussions and suggestions for future studies.

MATERIALS AND METHODS

Survey Content

The core of planning a health survey is to decide on the topics that should be included. The content of a student health survey should represent and address the specific goals of the overall project and university, respectively. These may vary from university to university and from project to project. Therefore, prior to planning a health survey, the stakeholders need to clarify the specific goals of their undertaking. Within *the Healthy Campus Mainz* project, we pursued a comprehensive approach aiming to address a wide range of health-related topics. We followed the World Health Organization's understanding of health as consisting of the physical, mental, and social dimensions of wellbeing (9), and can name mental health, physical activity, and media use as some specific examples of our targeted health topics. Additionally, in accordance with the prevention law, we aimed to identify the potential health-related risk groups within the student population concerning their sociodemographic factors, field of study, and specific/vulnerable phases during enrollment at the University. Furthermore, as stated in several articles, determinants of health (behavior), such as personality factors and structural conditions, are relevant aspects to be investigated (7, 10, 11). This is also important as understanding why individuals tend to engage in a specific health behavior contributes to an evidence-based planning of health-promoting interventions. Only by addressing the relevant determinants that have a causal relationship with health conditions can interventions be effective (12). Based from reviewing the literature and former health surveys (4, 8), the interdisciplinary research team of *Healthy Campus Mainz* decided to employ established and validated instruments wherever feasible, and to minimize the use of self-developed scales. The good psychometric quality of assessment tools enhances the reliability and validity of the gathered information. In addition, it makes the findings comparable to other studies and allows generalization. It was particularly the aim to cover new aspects that had not been represented sufficiently in other surveys, namely, media use and utilization of medical prevention services. We also wanted to examine the determinants of health, and to, thereby, portray a broad view on health. A recent systematic umbrella review revealed that these topics often have been neglected in former studies among university students (13). Consequently, the following topics were covered in the survey consisting of ∼270 items (a detailed list of included scales can be found in the **Supplementary Table 1**):

- health condition
  - overall health, mental health, chronic diseases, and disability
- health behavior
  - physical activity, presenteeism/absenteeism, diet, media use, procrastination, substance use (including neuroenhancement), vaccination, and oral hygiene
- determinants of health condition and behavior
  - determinants related to: sociodemographic factors, biography, social factors, individual psychological factors, health literacy, and structural conditions (resources and demands)

Methodological Considerations

Many different aspects play together when it comes to reaching the target group while aiming for a large and representative sample. In the following sections, we will describe our strategy accordingly.

Survey Method

Choosing the appropriate survey method requires careful consideration. The *Healthy Campus Mainz* team decided to use an online questionnaire since the target group seemed to be familiar with online surveys. Students spend a great amount of their time online for private and study-related purposes (14). Online surveys provide a great opportunity to reach many people in a university setting (15). In addition, the monetary savings of an online survey were a reason for this format, as there is no need to print the questionnaires on paper (16) and costs for typing in data are circumvented.

To reduce concerns about the anonymity and adherence to the privacy policy of an online survey that may prevent people from participating, it was stressed in the introduction of the survey that it adheres to the privacy policy and that it is strictly anonymous.

Questionnaire Design

Choosing an adequate length of a survey generally depends on the content and context in which the survey is performed. The estimated time for completion of the ∼270-item-survey was 35–45 min. This still seemed to be an adequate amount of time students would be willing to provide if the survey is connected to an appealing incentive strategy. Even though one might argue that a shorter survey would increase the likelihood for a higher response rate (17), to us, the decision had to be prioritized according to the content. As previously mentioned, our focus was to include many different facets of health and link them to a variety of potentially interacting determinants (12). In order to minimize bias in the results, it is important to design the questionnaire carefully (18). Therefore, the construction of the questionnaire needs to take the further described aspects into account. Validated short forms of established standardized questionnaires, if applicable, should be used preferably instead of long, time-consuming versions. This brings the advantage of the quick assessment of a variety of target variables and, at the same time, makes the overall questionnaire shorter, hence, reducing preparation time and making dropout less likely. Furthermore, using established standardized questionnaires goes along with higher objectivity and reliability. If available, the normative data of these questionnaires also allow comparison with other populations and enable the generalization of the findings in terms of validity aspects (19).

The inclusion of a moderation text throughout the questionnaire that provides easy transitions from question to question was a crucial part of the questionnaire design. To keep participants motivated, a process bar at the bottom of the page was included. In addition, motivating phrases and Graphic Interchange Formats (GIFs) were incorporated. The questionnaire was designed using the software *Unipark*. Prior to performing the survey, 12 students participated in a pre-test, which resulted in minor adaptations of the questionnaire according to their suggested feedback.

Recruitment Strategy and Survey Promotion

The timing of the survey also requires consideration in order to receive many survey responses. We chose to invite participants in the middle of the semester until the end, because the workload would seem more representative of their typical study demands and its relation to health (behavior) as opposed to the beginning of the semester. This might vary, though, between different university systems in different countries. The survey was open for participation until the beginning of the semester break when students typically still take exams or work on assignments.

Conducting a health survey among university students aiming for a high response rate and representativity of the whole population was, as already mentioned, important to us. That is why a carefully considered recruitment strategy was necessary. Overall, the recruitment took place for 7 weeks. In order to reach as many students as possible, an email including a link to the survey was sent to the whole student body via the system mail of the University of Mainz. Thereby, all students who were currently enrolled at the University received an email to their account where they would normally receive important notifications (e.g., about their grades). The emails were tailored to the target audience and the incentives were emphasized in order to increase motivation. In addition, the emails highlighted the overall project goals of *Healthy Campus Mainz*, the need for student participation and the health benefits for students regarding long-term study environment changes at the university. Consequently, four reminder emails were sent when the participation rate seemed to drop or almost stagnated.

As part of our survey promotion strategy, we additionally tried to serve many different communication channels to remind the students of our survey and to motivate them for participation. That is why, secondly, large lectures were visited by different members of the *Healthy Campus Mainz* team. Students were invited to participate in the survey according to a protocol by introducing the overall project goals and highlighting the incentives. Similarly, lecturers of smaller classes were asked to show an invitation during their lecture on the classroom screen. Thirdly, survey promotion on campus took place by placing marketing material like posters, leaflets, post cards, and stickers on pinboards and common areas, such as the cafeteria. In the process of designing the marketing material, a great attention had to be paid to creating an appealing design, catchy slogans, and to provide precise and the most relevant information. Face-to-face promotion on campus took place, and a chillout-area on campus was installed where students were invited to fill in the questionnaire on tablets or their smartphones in private. Handing out fresh fruits served as an incentive. Furthermore, press articles in the local news were released that announced the health survey.

Another important part of the promotional strategy was the use of social media, as it has been shown to be an appropriate strategy for reaching a young and large sample (20). A project Instagram account was launched shortly before the start of the survey. In order to gain followers, the marketing material for the survey included the name of the project's Instagram page, and during the recruitment in the lecture, people were invited to follow the page. On Instagram, regular posts and so called "stories" were posted to invite participants and give updates about the current participation rate. Besides this, other stakeholders on campus shared the information on the survey on their social media channels (Instagram and Facebook) as part of the survey promotional strategy.

Incentive Strategy

In order to maximize participation, it was crucial to have an incentive strategy which appeals to the broad masses of the student population. That is why a small survey among students ($n = 24$) about the incentive strategy was conducted in advance to identify what would motivate them for participation. It turned out that they would prefer a mix of small monetary and non-monetary incentives. Zheng et al. (21) also found that a mix of incentives would be an important factor in the recruitment of participants for health surveys. Consequently, to reach a wide spectrum of different people, a mixed incentive strategy was chosen. The main incentive was the following: *If 5,000 people complete the questionnaire, 1,000€ will be donated to the child cancer aid of Mainz*. This charity organization was chosen since it is directly linked to the topic of health and, desirably, it could create an emotional response. In addition, the promise of a charitable donation can activate the respondents' altruism (22). Throughout the whole survey conduct, the students were informed via reminder emails and social media about the current number of completed surveys in order to further promote participation. Besides this, lottery of gift cards for local gastronomy providers and an online store functioned as monetary incentives. We included 13 gift cards for local gastronomy providers (7×24€ and 6×40€). In addition, we offered 15 gift cards for an online store (5×100€, 5×50€, and 5×20€).

RESULTS

Of the around 32,000 students at the University of Mainz, 5,006 participants viewed the first page of the online-questionnaire; of whom, 4,714 continued further with the survey. Answering the first question of the questionnaire regarding health was a prerequisite in order to be included for further analyses. Participants who completed the questionnaire in <20 min were excluded since this appeared not to be enough time in order to fill in the questionnaire conscientiously/carefully. Also, cases with values that were not in the value range were controlled manually and excluded if they did not seem plausible. After manual data cleaning according to the just described predefined criteria, the

final cleaned sample was 4,351, demonstrating a response rate of 13.9% of the total student population at the University of Mainz. Eventually, 3,914 participants fully completed the survey. On average, participants spent 43.5 min to complete the survey.

The time of respondence seemed strongly dependent on the reminder emails that were sent. Accordingly, the first invitation mail resulted in the most completed questionnaires. **Figure 1** gives an overview of the response/access over time and dates when reminders were distributed. Note, that the first reminder email did not result in as many responses as typically would have been expected due to a technical error in the distributed email that could have disturbed the students. The final reminder was sent at the beginning of the semester break, when students do not have any classes but some have tests and assignments. This resulted in more participants than the previous reminders.

The majority (n = 3,065; 70.5%) of the participants were female, 28.6% (n = 1,246) were male, and 0.9% (n = 39) identified themselves as diverse. Compared to the gender distribution of the University of Mainz as a whole, women were overrepresented by 11.5% percentage points. The mean age was 23.8 and, thereby, approximately representative of the whole student body of the University of Mainz that has a mean age of 24.7. **Table 1** provides an overview of the participant characteristics.

Participants were enrolled in different degree levels. 52.0% (n =2,261) pursued a Bachelor's degree, 21.1% (n = 920) a Master's degree, 22.5% (n = 977) a state examination, and 3.4% (n = 146) a PhD. Other degree levels that will soon expire or are not very common in the German system were only represented with a very few students. Students from all faculties and from many different study disciplines, such as social sciences (e.g., psychology), economics, and law, participated. A large number of students from the sample was from the faculties of *Philosophy and Philology* (n = 601; 13.8%) and *University Medicine* (n = 582; 13.4%). **Figure 2** shows the response rates of each faculty in relation to all students of the according faculty at the university. Despite the fact that we reached all faculties, it shows that we did not reach students in every single faculty to the same extent. The faculty *Social Sciences, Media, and Sports* had the highest response rate with 15.5%, followed by the faculty of *University Medicine* with 15.1%. The *Mainz Academy of Fine Arts* (0.8%), the *Mainz School of Music* (3.9%), and the *Faculty of Catholic and Protestant Theology* (3.6%) showed the lowest response rates.

DISCUSSION

The aim of the current paper was to provide an example of how to perform a health survey among university students. This article should not be seen as a guideline that is "set into stone" but rather as an aid with useful hints for other universities in their similar undertakings.

The health survey at the University of Mainz had a slightly higher response rate (13.9%) compared to a similar health survey by Holt and Powell (4) that resulted in a response rate of 10%. Similar health topics were assessed but they additionally asked for health care utilization, which could be interesting for further investigations at the University of Mainz as well. In Germany, the response rate of a previous health

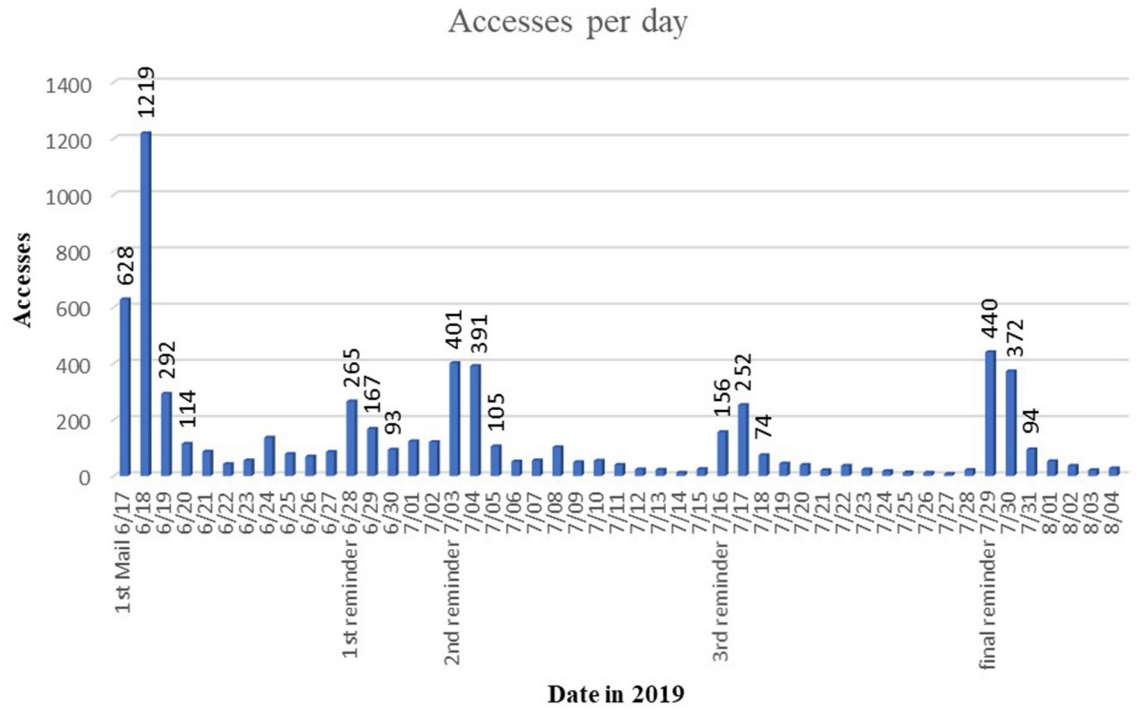

FIGURE 1 | Accesses to the online survey per day during the whole survey period.

survey was 9% (23). Compared to other studies, the sample of this health survey is quite large, despite the length of the survey. A possible explanation for this could have been the promotion of the survey via multiple channels and the differentiated incentive strategy. At the Technical University Kaiserslautern (24), 1,383 participated; and at Freie Universität Berlin, 2,620 participated (25). One has to note that some other studies do not report completion or response rates, which makes comparison more difficult. Despite the fact that response rates seem to be an important aspect, the pursuit of a large sample is also important when one aims to perform complex statistical analyses. This is most certainly the case in our project as we do not only want to assess the health status and behavior, but beyond that, identify potential determinants of health status as well as behavior. This goes along with needing more variables that are assessed in the questionnaire. Therefore, we had to compromise the risk of a lower response rate due to the survey length with a more comprehensive data. We also aspire longitudinal study-designs in the future. In the meantime, one publication about health information seeking behavior of university students that is based on the data collected through this described survey has already been published by Schäfer et al. (26). It will be followed by several other studies with different focus areas, such as mental health (27, 28).

When interpreting the results, it needs to be considered that the time frame during which the data were collected, the students might have been exposed to a different work load compared to other phases of the semester due to exams and assignments. If other universities consider to transfer parts of the approach to their university, they need to take their overall project goals, specific characteristics of their university, and also, the available resources into account and adapt the approach accordingly.

Potential Pitfalls and Further Considerations

The survey was only conducted in German, hence, international students, who are not fluent in German, were not able to take part in the survey. Therefore, it is possible that problems of this specific group, which may relate to their different cultural background (29), could not have been detected. Then again, the administration of multi-lingual questionnaires requires measurement equivalence between the applied language versions and the different participating cultural groups which is not sufficiently tested for in most cases (30). Potentially limiting the results is the self-reporting assessment of the survey. Especially in regard to sensitive health topics (e.g., illicit drug use), socially desirable answers are possible (31). It has been found that sensitive questions are not always answered correctly since people tend to give socially desired responses (31).

TABLE 1 | Participant characteristics.

All, *n* (response rate in %)	4,351 (13.9)
Gender, *n* (%)	
Female	3,065 (70.5)
Male	1,246 (28.6)
Diverse	39 (0.9)
Age, years (MW ± SA)	16–73 (23.8 ± 4.4)
University semesters, (MW ± SA)	1–45 (7.1 ± 4.9)
Degree, *n* (%)	
Bachelor's degree	2,261 (52.0)
Master's degree	920 (21.1)
State examination	977 (22.5)
PhD	146 (3.4)

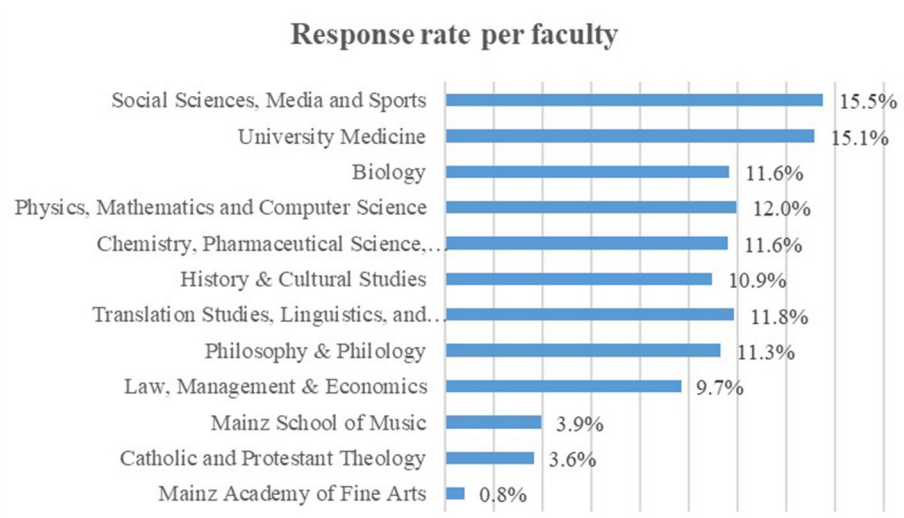

FIGURE 2 | Survey response rate distributed for faculty.

Since a large number of the participants were female and from certain fields of studies, the findings of this survey might be more valid for these groups and not generalizable. Especially in the field of mental health, sex-difference are common phenomena affecting reporting and help-seeking behavior (32). The higher response rate of females, however, seems to be a common issue in online studies among students (33) and in health surveys (34). Having this in mind, researchers who plan to do similar health surveys could intensify their efforts to recruit male participants and the typically underrepresented fields of studies by investing more in survey promotion. In our particular case, for instance, the Faculty of Fine Arts is not located on the same campus as the other ones. This could be an explanation for why other faculties on campus could be better reached by the use of face-to-face recruitment and lecture visits. One also has to note, as a limitation of our survey the data, that statistical analyses to study group differences cannot be performed with certain field of studies when the sample size is too little.

Future health surveys should try to improve target group specific recruitment and incentive strategies for traditionally underrepresented groups such as males and students from certain study disciplines even further. This would not only include advancing marketing strategies, but also refining the incentive strategy, for example, by including sub-goals within the donation goal. Another interesting option to study different incentives would be to see how many students participated with no incentive (email one), with the charity incentive (email two), and with the gift cards (emails three and four). However, the feasibility of this strategy would need to be taken into account based on the rest of the marketing strategy. Besides this, specific attention should be paid to the ways contacted persons converted to participants by tracking or assessing the source that made people actually participate.

CONCLUSIONS

Aspects that should be taken into consideration throughout the planning process of a health survey among university students are the following:

- Planning the topics of the survey in accordance with your project goals and based on the circumstances at your University.
- Using short, valid forms of established questionnaires, if applicable.
- Using an online survey is appropriate for the target group of students. Email invitations to the whole target population seem useful for recruitment.
- For survey promotion using many different communication channels, in particular lecture visits, social media, and face-to-face on campus promotion. Focus promotion efforts on typically underrepresented groups.
- Offering a variety of incentives and making them interesting or emotionally relatable to the target group.

To conclude, with this article, we wanted to share some of our "lessons-learned" from the *Healthy Campus Mainz* project and provide a platform for discussion. We hope that our suggestions are helpful for those planning health surveys among students, and that others share their experience and best-practice cases to guide an evidence-based process. We invite other researches in the field to also report their strategies for survey development and promotion that seemed beneficial but, also, explicitly the ones that did not work out and innovative ideas are needed instead.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

Ethical clearance was received by the Ethical Committee of the Medical Association (Ärztekammer) Rhineland-Palatinate (No. 2019-14336). Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

JR, TR, and PD analyzed the data. JR and PD were the major contributors in the writing process. All authors were involved in the development and performance of the survey. All authors contributed in writing the manuscript. All authors read and approved the final manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.616437/full#supplementary-material

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Promoting Students' Health at University: Key Stakeholders, Cooperation, and Network Development

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Background: Cooperation among university units is considered a cornerstone for the promotion of students' health. The underlying mechanisms of health-promoting networks at universities have rarely been examined so far. Shedding light on partnerships is generally limited to the naming of allied actors in a network.

Objectives and Methods: In this study, we used network analysis intending to visualize and describe the positions and characteristics of the network actors, and examine organizational relationships to determine the characteristics of the complete network.

Results: The network analysis at hand provides in-depth insights into university structures promoting students' health comprising 33 organizational units and hundreds of ties. Both cooperation and communication network show a flat, non-hierarchical structure, which is reflected by its low centralization indices (39–43%) and short average distances (1.43–1.47) with low standard deviations (0.499–0.507), small diameter (3), and the non-existence of subgroups. Density lies between 0.53 and 0.57. According to the respondents, the University Sports Center is considered the most important actor in the context of students' health. Presidium and Institute of Sport and Sports Science play an integral role in terms of network functionality.

Conclusion: In the health-promoting network, numerous opportunities for further integration and interaction of actors exist. Indications for transferring results to other universities are discussed. Network analysis enables universities to profoundly analyze their health-promoting structures, which is the basis for sustained network governance and development.

Keywords: organizational network analysis, health-promoting universities, university students' health, cooperation, stakeholder identification, network governance, network development research

INTRODUCTION

Problem Statement and Relevance

Despite their young age, university students are a vulnerable group from a health perspective (1–3). Because of the potential multiplier role of university students as future leaders and decision makers, health promotion in higher education institutions is of special importance (4). Because universities are complex organizations, systematically navigating health promotion is necessary for it to be effective and efficient (5).

Therefore, health-promoting universities are being called upon to work according to the *setting approach*, which means that relevant stakeholders from different disciplines and sectors within the campus community should be cooperatively involved in the process of embedding health into all aspects of campus culture and of providing health-promoting activities for students (6, 7). Collective action by a wide range of stakeholders has been seen as a key for effective intervention delivery in health promotion since a single stakeholder can hardly be in control over the complex interplay of determinants of a targeted population's health (8–10).

By cooperating, stakeholders can attain and provide additional resources, share information and knowledge, minimize the duplication of effort, reach additional members of the target audience, earn greater credibility, and tackle the determinants of health in a holistic approach through the provision of integrated services (8, 11–14). However, stakeholders from various disciplines with unique expertise, interests, values, and expectations may not have a history of working together or even view themselves as having related goals, making setting-based health promotion a difficult undertaking (15–17).

State of Research and Research Gap

Cooperation processes and structural characteristics of various public health networks have been studied in the past, including active living networks (18), healthcare and patient safety networks (19), community academic partnerships for health (20), community care networks (21, 22), substance abuse prevention networks (11, 23), children's health initiative coalitions (24), elderly care networks (25), HIV/AIDS service organizations (26), mental health services (27, 28), woman organizations (29, 30), and cancer support networks (31).

The number of colleges and universities promoting health for students is rapidly increasing (32). The underlying mechanisms of health-promoting networks at universities, however, have rarely been examined so far, and that although multiservice cooperation among the university community is considered a cornerstone for the promotion of health in the university setting (4, 33). In their study on implementation status quo of the health-promoting university concept, Suárez-Reyes et al. (34) have pointed out that "the key principles of health-promoting universities and the framework for action, along with the key components for their implementation, are clearly described, but information on how universities make use of these guidelines to operate in a real context is scarce." Newton et al. (32) stated in their study on the operationalization of the concept of healthy universities that there is a need for a whole-university approach that pays attention to the complex interactions and interconnections between component parts and highlights how the organization can function effectively as a social system. Reviews have indicated that cooperative practice among units of the university does seem to take place in the context of student health (35, 36), but evidence about communication and cooperation among units promoting health, especially for university students, is almost non-existent, while other aspects of promoting students' health at university are relatively well-studied (35–37). A multi-methodical but not network analytic approach to map out and characterize health-promoting structures was used at the Florida International University (USA) (38). Here, information on localization, resources, and partnerships of health promotion initiatives was collected *via* semi-structured interviews with stakeholders in health-related roles among other things. Shedding light on partnerships, however, is then limited again, as is commonly the case (39, 40), to the naming of allied actors, and does not provide in-depth information about structural characteristics of networks promoting health at university.

Theoretical Background

The present network analysis falls into the research branch of *organizational network analysis* (41). An organization can be conceptualized as a network in which organizational members or units (consisting of the major representatives of those organizations for example) are nodes interacting with each other, establishing relationships (42). These networks between organizational units are referred to as *intraorganizational networks*, as opposed to *interorganizational networks*, where the focus is on networks between different organizations (43, 44).

Within the research branch of *organizational network analysis*, the present network analysis belongs to the category of *network development research*. Here, so-called *network structure constructs* at all three levels (node, dyadic, and network) are utilized to capture detailed structural features of networks (45). By capturing the structural features of a network, network structure constructs can help to understand the positions and roles of actors and indicate the available opportunities for progress in the network (46).

Purpose

In this study, we used network analysis with the aim to

- visualize and describe the positions and characteristics of the network actors to identify key-stakeholders;
- examine organizational relationships to determine the characteristics of the complete network; and
- explore the network structures to designate starting points for network development.

The research questions are as follows:

- Which actors are relevant concerning student health?
- How is communication and collaboration between actors structured in the network?
- Which network-related optimization potentials can be identified?

METHODS

Setting

To address student health issues at the German university at hand, the Institute of Sports and Sports Science and the Central Scientific Institution for Key Competencies launched a participatory health promotion project focused on identifying barriers and opportunities related to integrating evidence-based health promotion programs offered on the university campus in partnership with the Presidium, the Techniker Krankenkasse (German health insurance), Student Support Service, University Sports Center, and student representatives. The university has a long history of health promotion regarding staff members (corporate health management) and partially regarding university students (e.g., health-related courses at the University Sports Center or key qualifications for coping with academic stress). However, a holistic management approach for the promotion of students' health was undertaken at the beginning of this project in 2017. Stakeholders of the project agreed on developing a community-based participatory research approach (47). Through cooperation with the different stakeholders at the university, it was expected that structural change could be implemented more efficiently. Some of these actors provide health promotion or education activities; others were not traditionally associated with health and academic stress themes. This paper reports the findings from a network analysis among actors of the university, which was conducted after the project had been in operation for about 2 1/2 years. The network analysis primarily provides data on the extent to which actors interacted with one another in the network.

Sampling

To identify all actors that address student health at university, a multifaceted snowball sampling process was initiated (16, 48, 49). First, a pre-defined list was created by the researchers based on the research of project proposals and documents and a screening of the literature. Then, the head managers from the participatory health promotion project for students from the Institute of Sports and Sports Science and the Central Scientific Institution for Key Competencies were asked as key informants to identify the actors with a unique role and others they deemed relevant in the area of health promotion at the university. This resulted in a final sample of 33 actors, who focus on understanding or promoting the health of students at university or who are potentially able to influence student health. The actors were quite diverse. Some of them were actual health providers, others provided health-related information and education, and still others had only indirect involvement with students' health. Fourteen of these organizations were engaged in the project at the time (*via* membership of the steering committee or through engagement in the working group), and the rest was identified as potentially relevant.

Questionnaire

The questionnaire developed was based on previous work on health- and physical activity-related networks done (16, 49–52). It requested basic information on the estimation of health topics and potency of actors but focused primarily on obtaining information on relationships regarding communication and cooperation among the actors. The questionnaire comprised 18 questions. The quantitative relational constructs measured among the university units were communication and cooperation, operationalized as the frequency of contact and type of cooperation. For each question, a list of the 33 actors was provided. Regarding *communication,* respondents were asked to indicate, how often they are in contact with all of the 33 actors. Communication frequency response options ranged from "never" (0), "less than annually" (1), "annually" (2), "half-yearly" (3), "monthly" (4), "weekly" (5), to "daily" (6). In matters of cooperation, respondents were asked how they would describe their relationship with each of the 33 actors. The cooperation response scale ranged from no cooperation (0); information sharing only (1); informal cooperation (loose cooperation to reach common objectives) (2); formal cooperation (close cooperation in a team to reach common objectives) (3); partnership (close cooperation for longer time period, e.g., in several projects) (4). In order to identify further starting points for network governance and development, respondents were additionally asked about their points of contact regarding their area of work with several health-related topics, perceived importance of these health topics for student health (on a five-point Likert scale from 1 = unimportant to 5 = very important), the relevance of the other actors regarding health topics, and the importance of the other actors regarding student health *per se* (on a five-point Likert scale from 1 = unimportant to 5 = very important). Health-related topics were identified by scanning the research field of health-promoting universities with a focus on students. Apart from that, questions were asked about service duties (e.g., freedom of choice), staffing level, and the employment relationship (*Note: The analysis of these questions is not part of this publication*). The respondents were also given the opportunity to list further relevant actors and health topics, which were not included in the list and which they thought were relevant to students' health. Most questions and answers were administered with accompanying definitions and examples. The questionnaire was prefaced with instructions and data protection information and was piloted with the head of the Corporate Health Management and the deputy managing director of the Central Scientific Institution for Key Competencies.

Data Collection

Quantitative and qualitative organizational network data were collected during winter semester 2019/2020 by highly structured face-to-face interviews from trained research assistants using an interview guide in an interactive format with actor and health topic lists and response scale cards. The main representative of each of the 33 units (generally the executive director or, in some cases, a staff member who was more knowledgeable about the issue) received a personalized interview request for this purpose, including a cover letter explaining the research study and a privacy statement. Individuals were known from most units; otherwise, contact persons were researched at the homepages of the units. Informed written consent was obtained from all respondents before the start of the interview. The

average interview lasted about 60 min. All in all, data collection took 6 months. Approval for this study was granted by the staff council and the data protection office of the university as well as the staff council of the Student Support Service. In the end, 28 out of 33 units completed the survey providing an 85% response rate. Three of the 33 units (Student Groups, Deaneries, and Institutes) represented a collective of various actors and were therefore not interviewed. The General Student Committee and the Student Working Group for Culture and Communication were not available for an interview. In total, 35 persons were interviewed, since the Institute of Sports and Sports Science (three respondents), the Central Scientific Institution for Key Competencies (five respondents), and the Student Support Service (two respondents) in their roles as central stakeholders in the context of student health had more than one respondent.

Data Analysis

Survey data gathered through the questionnaire were entered to SPSS 25 Statistical Package by study ID for cleaning and initial data exploration on the basis of a codebook. Ten percent of data were randomly double-checked for accuracy—the agreement was 100%, why a higher double-check was refrained from. Data from the two network questions were then exported into Microsoft Excel for the creation of adjacency matrices, indicating which actors reported links of cooperation and communication to other actors. To reconcile divergent response pairs, two techniques were used: reconstruction (when only one actor in the dyad provided a valid response to a question, response given by the other actor in the pair was used) and symmetrizing (minimization was used to resolve rating discordances between two actors in a dyad). When both actors in the dyad did not give a valid response to a question, it was treated as a missing value, which was the case for 20 (5 non-interviewed actors × 4) out of 1,056 ties for both networks, corresponding to a missing rate of <2%. If multiple respondents were interviewed from one unit, we used the responses given by the person highest in the hierarchy (11). Data were then managed and analyzed using UCINET 6. For data analysis, various descriptive and statistical procedures were applied. To identify actors' positions and key stakeholders, various centrality parameters (degree, betweenness, closeness, eigenvector) at the node level of analysis were calculated and assessed for all actors. For an analysis of structural cohesion at the network level, various measures of network cohesion were calculated (15, 41, 53): average degree (average number of edges per node in the graph), centralization (extent to which the graph shows a centralized structure), density (number of existing ties divided by the number of possible ties), fragmentation (extent to which the network is broken into fragments of unconnected nodes, dyads, and cliques), average distance [average number of steps along the shortest paths (geodesics) for all possible pairs of network nodes], and diameter (largest geodesic distance in the network). To analyze the association between the network of communication and the network of cooperation, inter-network correlations were calculated using the quadratic assignment procedure (QAP) (54). Network maps representing cooperation and communication between actors were visualized using GEPHI 0.9.2.

RESULTS

Respondents ($N = 35$) were asked to select from 13 different topics related to students' health that play a role in the course of their everyday professional lives. On average, each respondent selected six topics. Stress management (71% of all respondents), workplace design (63%), and key qualification and further education (63%) were mentioned most frequently, followed by sports and relaxation (60%), study organization (54%), social counseling (51%), study counseling (51%), curriculum (49%), campus design (46%), campus safety (40%), nutrition (29%), addiction counseling (17%), and health diagnostics (14%).

The network actors interpreted the question openly, which means that they assumed to have points of contact with the topics, even if they could not present any concrete offers themselves, but only referred students to offers of other actors. The respondents also found the response to the topics suitable if they were only relevant for a certain small part of the student body with whom they were in contact. Health-related topics mentioned additionally, once each, were health assessment, student representation possibility, sustainability, sleep, and peer-to-peer counseling. When asked to choose the topic, which plays the most important role in the everyday professional lives of the actors, respondents mentioned study organization ($n = 4$), sports and relaxation ($n = 4$), key qualification and further education ($n = 3$), workplace design ($n = 3$), study counseling ($n = 3$), and named once in each case: campus design, nutrition, health diagnostics, social counseling, campus safety, and sustainability. Eleven respondents did not make a statement in this regard, because they could not decide on 1 of the 11 topics.

When asked for the importance of the topics concerning students' health, respondents regarded stress management ($M = 4.46$, $SD = 0.7$), social counseling ($M = 4.34$, $SD = 0.8$), and sports and relaxation (4.23, $SD = 0.9$) as the most important topics, followed by workplace design ($M = 4.11$, $SD = 0.9$), study counseling ($M = 4.00$, $SD = 1.1$), study organization ($M = 3.80$, $SD = 1.3$), nutrition ($M = 3.77$, $SD = 1.0$), curriculum ($M = 3.71$, $SD = 1.2$), key qualification and further education ($M = 3.69$, $SD = 1.1$), addiction counseling ($M = 3.57$, $SD = 1.0$), campus design ($M = 3.40$, $SD = 1.1$), campus safety ($M = 3.34$, $SD = 1.0$), and health diagnostics ($M = 3.20$, $SD = 1.0$).

To assess how respondents view other actors in the network concerning students' health, respondents were asked to rate the importance of each actor. Respondents regarded the University Sports Center ($M = 4.66$, $SD = .0.5$), the Representative for Students with Special Needs ($M = 4.51$, $SD = 0.6$), and the Student Support Service ($M = 4.46$, $SD = 0.9$) as the most important actors (see **Table 1**). The mean ratings ranged between 2.24 and 4.66. Interestingly, some of the actors (e.g., Representative for Students with Special Needs, Study Center for Visually Impaired Students and Medical Services) deemed important here play a minor role in previous efforts to promote student health within the participatory health promotion project. This result corresponds to the network maps and structure constructs presented later.

Respondents were also asked to indicate the most important actor regarding the 11 health-related topics. The mentioned

TABLE 1 | Importance of the units.

Units	Mean (SD)	*N*
University Sports Center	4.66 (0.5)	35
Representative for Students with Special Needs	4.51 (0.6)	35
Student Support Service	4.46 (0.9)	35
Corporate Health Management	4.35 (0.9)	34
Institute for Sports and Sports Science	4.29 (0.8)	35
Study Center for Visually Impaired Students	4.09 (0.9)	35
Presidium	4.03 (1.1)	35
Central Scientific Institution for Key Competencies	4.00 (0.7)	35
Sports Club	3.94 (0.9)	34
Medical Services	3.91 (1.1)	35
Student Group: Nightline	3.89 (1.1)	35
General Student Committee	3.66 (0.9)	35
Library and Learning Space Development	3.60 (1.2)	35
Equal Opportunities	3.59 (1.0)	34
Institutes	3.57 (1.0)	35
Service Unit for Higher Education and Student Affairs	3.52 (1.2)	33
Safety and Environment	3.52 (1.1)	33
Specialists for Occupational Safety	3.51 (1.1)	35
Student Groups	3.50 (1.0)	32
Center for Information and Counseling	3.44 (1.1)	34
Student Services	3.43 (1.1)	35
Student Parliament	3.37 (1.2)	35
Diversity Management	3.35 (1.1)	34
Campus Development	3.33 (1.1)	33
Student Working Group Culture and Communication	3.26 (1.1)	35
Deans' Offices	3.26 (1.2)	35
International Students Office	3.24 (1.2)	34
Student council Conference	3.06 (1.2)	35
Center for Applied Cultural Studies	2.91 (1.0)	35
Green-Alternative Student Group	2.86 (1.0)	35
Center for Teacher Education	2.79 (1.1)	33
Human Resources Development and Vocational Training	2.77 (1.2)	35
Innovation and Relations Management	2.24 (1.1)	33

TABLE 2 | Most competent units regarding the health-related topics.

Topics	Most competent units	*N*
Campus design	Campus Development (26%), Safety and Environment (20%), Facility Management (9%)	35
Curriculum	Institutes (38%), Deans' Office (24%), Service Unit for Higher Education and Student Affairs (18%)	34
Nutrition	Student Support Service (39%), Institute for Sports and Sports Science (27%), Corporate Health Management (15%)	33
Workplace design	Specialists for Occupational Safety (27%), Library and Learning Space Development (21%), Facility Management (12%)	34
Health diagnostics	Institute for Sports and Sports Science (88%), University Sports Center (6%)	33
Key qualification and further education	Central Scientific Institution for Key Competencies (65%), Human Resources Development and Vocational Training (12%)	34
Social counseling	Student Support Service (43%), General Student Committee (17%), Study Center for Visually Impaired Students (9%)	35
Sports and relaxation	University Sports Center (54%), Institute for Sports and Sports Science (37%)	35
Stress management	Student Support Service (25%), Central Scientific Institution for Key Competencies (25%), Institute for Sports and Sports Science (16%), Corporate Health Management (16%)	32
Study Counseling	Center for Information and Counseling (65%), Student Services (12%)	34
Study Organization	Service Unit for Higher Education and Student Affairs (36%), Institutes (18%), Presidium (12%), Student Services (12%)	33
Addiction Counseling	Student Support Service (59%), Medical Services (25%)	32
Campus safety	Presidium (36%), Safety and Environment (30%)	33

Due to lack of space, single mentions have not been displayed.

actors with the respective percentage number can be seen in **Table 2** for every single topic. It can be seen that the perceived competence in terms of professional suitability and responsibility for a topic is distributed among different actors for each topic.

Furthermore, respondents were asked if there were any actors not included in this survey that they considered to play a significant role regarding students' health. Fourteen of the 35 respondents (40%) named at least one additional actor. The nominations are as follows: Facility Management (number of mentions: 6), General Services (4), Faculties (3), Conflict Management and Psychosocial Counseling (2), Student Councils (2), Service Unit for University Law and Academic Affairs (1), University Departments (1), Service Unit for Law (1), Adjunct Lecturers (1), Strategic Corporate Development and Communications (1), Canteen (1), Study Commission (1), Faculty Council (1), Physics Student Council (1), Social Club in the Student House (1), Center for Technology-Enhanced Learning (1), Representative for Refugees (1), and Vice-President for Higher Education and Student Affairs (1). Thus, 18 actors that were previously less in the focus of the participatory health promotion project but could play a meaningful role in improving students' health have been identified. Facility Management, General Services, and Faculties were mentioned by multiple respondents and are thus ideal targets for engagement efforts in the future.

Respondents were asked to rate their level of cooperation and communication with each actor from the list. Two network maps were generated from these variables for analysis. The first network map shows the cooperation linkages (**Figure 1**), and the second network map shows the communication linkages (**Figure 2**). Reciprocity of the original dataset was ∼0.5. Using the QAP procedure, there is a significant positive high correlation with $r = .85$ ($p < 0.05$) between the cooperation network with the communication network.

In terms of the cooperation network, 560 out of 1,056 possible ties of the network were realized, resulting in a density of 0.53. Almost half of these ties (228, or 41%) suggested a cooperation level of information sharing only, while the other cooperation

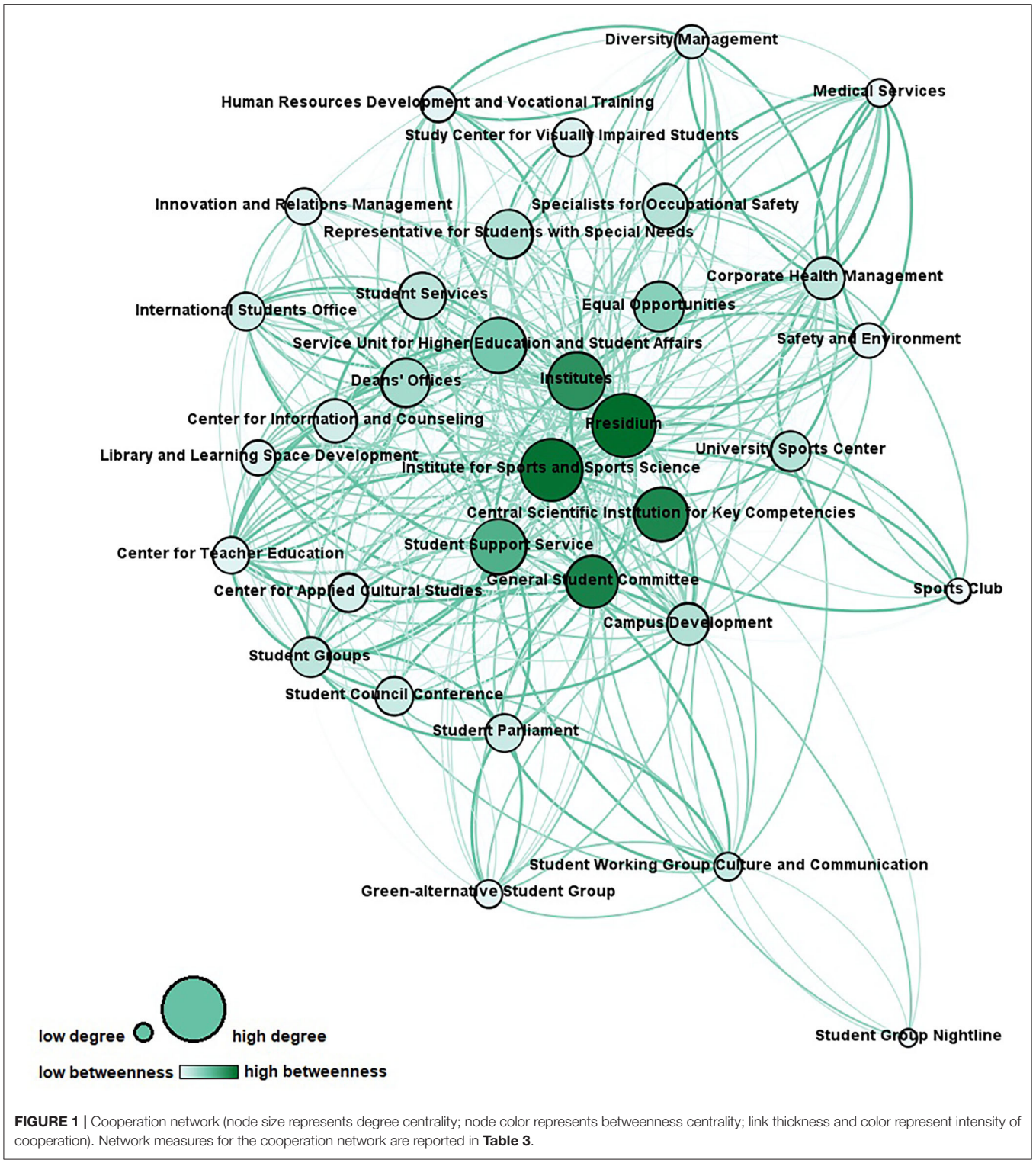

FIGURE 1 | Cooperation network (node size represents degree centrality; node color represents betweenness centrality; link thickness and color represent intensity of cooperation). Network measures for the cooperation network are reported in **Table 3**.

levels were as follows: informal cooperation (92, or 16%), formal cooperation (160, or 29%), and partnership (80, or 14%).

In terms of the communication network, 600 out of 1,056 possible ties of the network were realized, resulting in a density of 0.57. Ninety-two of these ties (15%) suggested a communication level of less than annually, while the other communication levels were as follows: annually (98, or 16%), half-yearly (202, or 34%), monthly (108, or 18%), weekly (74, or 12%), daily (16, or 3%).

TABLE 3 | Network Measures of the cooperation network (dichotomized data).

Measures	Cooperation network
Number of nodes	33
Number of ties	560
Average degree	16.97
Degree centralization	0.433
Density	0.53
Fragmentation	0
Average distance	1.473
Standard deviation Distance	0.507
Diameter	3

To identify key stakeholders in the original cooperation and communication networks, the following network structure constructs on actor level have been calculated (55–57):

- Degree centrality: to explore who is a central connector by means of the number of ties an actor has with others and can be considered prestigious and influential;
- Betweenness centrality: to explore who is a gatekeeper or information broker and connects various nodes in the network and therefore supports information exchange and has control over the network communication;

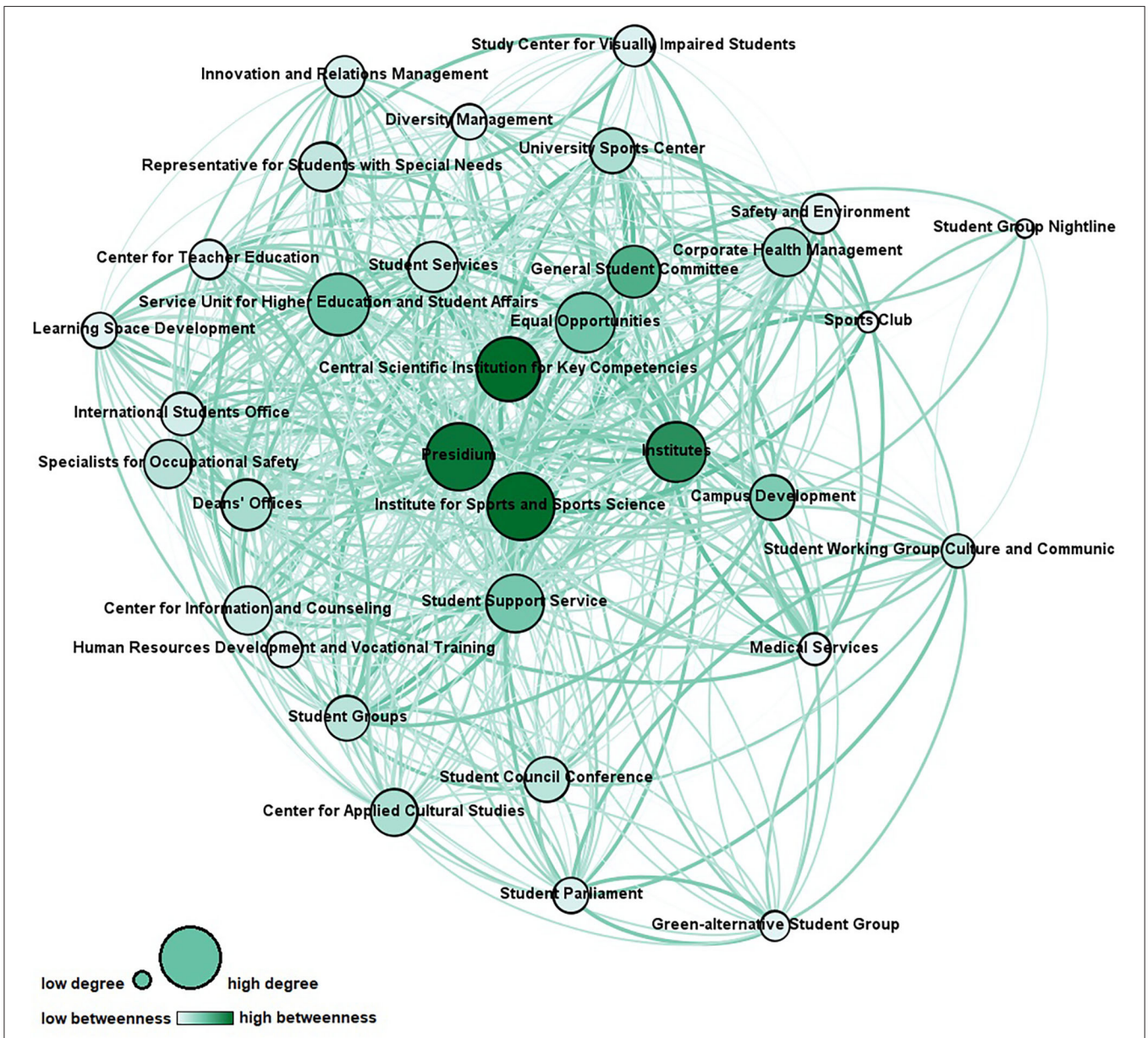

FIGURE 2 | Communication network (node size represents degree centrality; node color represents betweenness centrality; link thickness and color represent frequency of contact). Network measures for the communication network are reported in **Table 4**.

- Closeness centrality: to explore who is an autonomous actor and therefore close to all other actors based on the distance between nodes so that he can spread information efficiently; and
- Eigenvector centrality: to explore who is a popular actor by means of the number of ties an actor has with other high-scoring actors concerning centrality.

An overview of the scores for the most central actors can be found in **Table 5**.

To explore who is a *decentral specialist* providing specific knowledge, but is peripheral in the network, a comparison of the actors' legitimacy and competency attributions regarding students' health (see **Tables 1**, **2**) with their centrality scores has been made. Medical Services, the Student Group Nightline, the Sports Club, the Specialists for Occupational Safety, and the Center for Information and Counseling were identified as such.

DISCUSSION

Summary of Main Findings

The network analysis at hand provides in-depth insights into university structures promoting students' health comprising 33 organizational units and hundreds of ties. Both cooperation and communication network show a flat, non-hierarchical structure, which is typical for the university context (58). This structure is reflected by its low centralization indices and short average distances with low standard deviations, indicating that every actor can be reached by every other actor *via* one to two nodes as a rule. The largest geodesic distance in the network, which is expressed by diameter, is small, and with regard to fragmentation, the networks show the non-existence of subgroups. Density, in other words the ratio of observed ties to the number of possible ties, is relatively high. It is assumed that high density increases the probability that weak ties turn into strong ties in the future (59). Every node is connected with more than half of the networks' nodes on average, which is expressed by average degrees. Due to the compactness and connectedness of the network, it can be assumed that information is likely to reach everyone in the network quickly. The pattern of linkages of the cooperation network suggests that the highest number of relations among the actors were for information sharing. This finding is consistent with previous research on public health networks, which shows that stakeholders tend to communicate rather than cooperate as this is associated with less effort (60). The cooperation network and the communication network are highly correlated ($r = .85$, $p < 0.05$), showing that these two networks are not independent of each other. Simultaneously the density of the cooperation network is less pronounced than the density of the communication network. This is in line with current research findings, which show that communication can be considered a precursor to cooperation (54, 61). From network analyses in other settings, it is furthermore known that actors tend to form ties with similar ones because of the similar nature of work (16, 49). This phenomenon is called homophily (62) and can partly be observed within the present network (e.g., interconnectedness of the student groups).

TABLE 4 | Network Measures of the communication network (dichotomized data).

Measures	Communication network
Number of nodes	33
Number of ties	600
Average degree	18.182
Degree centralization	0.393
Density	0.568
Fragmentation	0
Average distance	1.434
Standard deviation distance	0.499
Diameter	3

Interpretation of Findings

Substantial cooperation between university actors with very different core agendas is needed for health promotion of university students (4, 33). Since it is a young field of activity with an unclear role distribution, university units may have limited experience at cooperating in this regard. The present findings allow identifying starting points for effective network development and governance in revealing key stakeholders as well as in discovering actors that should take on a significant role in the future process. Across the two networks, opportunities for further integration and interaction exist. According to the respondents, the University Sports Center, the Representative for Students with Special Needs, and the Corporate Health

TABLE 5 | Overview of the network measure scores for the individual actors in the cooperation and communication network.

Cooperation network	
Most influential actors based on degree	1. Presidium (85), 2. Institute of Sports and Sports Science (71), 3. Institutes (65)
Information brokers based on betweenness	1. Presidium (28.7), 2. Institute of Sports and Sports Science (27.9), 3. General Student Committee (25.0)
Most integrated actors based on closeness	1. Presidium (34), 2. Institute of Sports and Sports Science (35), 3. Institutes (38)
Most popular actors based on eigenvector	1. Presidium (1), 2. Institute of Sports and Sports Science (0.86), 3. Institutes (0.79)
Communication network	
Most influential actors based on degree	1. Presidium (114), 2. Institute of Sports and Sports Science (100), 3. Institutes (98)
Information brokers based on betweenness	1. Central Key Qualification Facility (25.4), 2. Institute of Sports and Sports Science (25.3), 3. Presidium (24.2)
Most integrated actors based on closeness	1. Presidium (34) and Institute of Sports and Sports Science (34), 3. Central Scientific Institution for Key Competencies (36)
Most popular actors based on eigenvector	1. Presidium (1), 2. Institute of Sports and Sports Science (0.89), 3. Institutes (0.87)

Management are among the most important actors regarding students' health. However, they only play a minor role in the cooperation and communication network thus far. Interestingly, four of the top 10 actors (see **Table 1**) have chosen sports and relaxation as the topic, which plays the most important role in their everyday professional lives, suggesting that this classic field of action of health promotion is of key importance in regard to promoting students' health. Still, the network actors cover all requested health-related topics, and it is noteworthy that topics that constitute the core business of universities (e.g., key qualification and further education, study counseling and curriculum) are not considered unimportant in the context of health promotion for students, which opens the possibility to integrate the topic of health crosswise at the university. Concerning cross-linkage of actors who contribute to the same health-related topic, strong relationships should be established, so that the division of tasks can be clearly defined and synergies created. Except for the General Student Committee, student groups tend to be located on the periphery of the network with fewer ties than central actors. Looking to the future, it will be important to find out under what circumstances it is desirable and achievable for them to be more integrated in order to ensure that they participate in the health promotion process and that their needs and requirements are adequately addressed. Besides, opportunities to strengthen the ties of *decentral specialists* are evident. The integration of distal nodes may lead to new insights and offers new input for the matter (63). Medical services, in particular, could take on a much more significant role with regard to student health in the future as part of the risk assessment of mental stress. Stakeholders from the participatory health promotion project for students (e.g., Presidium, Institute of Sport and Sports Science, or Central Scientific Institution for Key Competencies) play an integral role in both networks. The data confirm that the project already operates with key stakeholders and suggest to continue engaging these actors in activities for health promotion. Presidium and Institute of Sport and Sports Science are the most important actors in terms of the functionality in the network (see **Table 5**). The commitment of the presidium of a university, in particular, is regarded as a crucial factor for the success of health promotion efforts regarding students, and health-related disciplines can provide important impetus in the process (40, 64). Institutes should be involved in health promotion efforts in their position as multipliers with direct contact to all students. Besides, barriers to cooperation, for example, bureaucracy, differing goals or agendas of units, lack of time, and previous experiences of working together, should be considered in the development of the health promotion network (16, 49). For example, formal agreements could be used to determine goals in advance and define responsibilities for cooperation in this way to prevent the fear of a loss of autonomy and an impoverishment of resources on the part of the individual actors.

Theoretical papers in the context of health-promoting universities recommend the creation of an organizational structure to coordinate all actions related to health (40). While this is probably the first network that was analyzed this profoundly in the university setting on behalf of students' health, research from other fields allows concluding effective modes of network development and governance that can be applied in the context of a university. Goal-directed networks, such as the actor network of health-promoting universities, require a certain form of governance to utilize the benefits of cooperation among stakeholders (65). The network at hand shows characteristics of a "participant-governed" network, which is governed by virtually all involved units coordinating activities and making decisions (although stakeholders of the participatory health promotion project play a special role in it as a kind of "leading group"). Such networks are common in the field of health services to build community capacity (66). However, thought could still be given to whether a change in the governance approach might be useful. In "lead organization-governed" networks, for example, the network is led and coordinated by a legitimized central actor trusted by others (65). This form of governance also works with low commitment levels of the network members and is best suited for a moderate number of involved actors. To increase the efficiency of the network, a "network administrative organization" can also be considered, where governance is carried out externally by an independent unit, which is specifically set up to govern the network only (65). This approach best fits networks with moderate density and centralization, moderate to many network participants, and a moderately high goal consensus.

Limitations and Transferability

The survey questions and response items may have limitations. For example, it may be challenging to rate the level of cooperation or communication with another organization on the whole. The reputational snowball sampling could have biased the boundary specification, and therefore the sample. Having two different key informants might have led to a different list of actors. In terms of validity, the survey included a question regarding additional actors, and the evaluation on this matter did not suggest that significant units were missing from the network sample, except for the Facility Management and General Services. Usual concerns about the use of informants, who may have only partial knowledge about the underlying issue, were not a concern in this study, since, in general, the units' executive director or, in some cases, a more knowledgeable staff member has been interviewed. Anyway, a bias in reporting or from missing data is a possible limitation in network analysis with key informant interviews (11). In particular, the consistent consideration of multiple actors from each unit could have had an impact on the results of the network analysis. Apart from that, certain actors could have been ruled out through a selection bias since isolated actors have no network at all (67). Reciprocity of the original dataset was ∼0.5, reflecting uncertainty among respondents regarding the actual occurrence and magnitude of the relationships. The network analysis at hand included unconfirmed links, because using confirmed links only may underestimate the extent of cooperation (68). Minimization as an often-used symmetrizing approach was used to resolve rating discordances between two actors in a dyad conservatively (53). This first-time network analysis of health-promoting structures regarding students' health at a university maps hundreds of actor ties and reflects the views of dozen units, but since the analysis is

limited to the health promotion network at one single university, generalizations based on the available data should be made with caution. However, the fact that administrative structures of universities are basically comparable, at least in Germany and in the European higher education area (69, 70), allows for a transfer of the numerous indications for network development, such as:

- University executive board and health-related disciplines as key stakeholders;
- Crosswise integration of health promotion *via core-business*-units of university;
- Utilizing the potential of subordinate stakeholders (e.g. *decentral specialists*);
- Informed decision on network governance of the health-promoting network;
- Representation of student groups' participation *via* cooperation in the network; and
- Academic stress as focal point within health promotion for university students.

Future Direction and Conclusion

The present work has laid a foundation for future research that could include a longitudinal evaluation of the network by collecting data once again with the inclusion of the additional actors identified by respondents. Thereby, assessment should be extended by meaningful constructs (e.g., funding flow or resource sharing) to gain deeper insight into the network and by structural contingencies (e.g., network goal consensus or trust) to predict the effectiveness of network governance. Network analysis can thereby represent a new form of structure evaluation in health promotion, in which the emphasis is less on simple counts of program activities and more on the documentation of structural changes (11). Compared to other methods of identifying key stakeholders, network analysis is characterized by high validity and reliability as well as being time-consuming and resource-intensive (71). On a final note, this form of data collection enables universities to profoundly analyze their health-promoting structures, which is the basis for sustained network governance and development.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

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

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Health Literacy Among University Students: A Systematic Review of Cross-Sectional Studies

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Objective: The aim of this systematic review was to provide an overview of cross-sectional studies that examined health literacy among university students and to identify possible determinants related to health literacy.

Method: The current review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Three databases (PubMed, Scopus, and Web of Science) were systematically searched for cross-sectional studies that examined health literacy among university students. Results of included studies were narratively summarized.

Results: The systematic review includes twenty-one research studies. The majority of studies report health literacy scores among university students that are lower compared to reference samples. The health literacy of students is influenced by different variables (age, gender, number of semesters, course of studies/curriculum, parental education, and socioeconomic background).

Discussion: Health literacy activities should target all students. Universities should make use of their resources and offer health literacy courses for students in which content is used from disciplines available at the university (e.g., medicine, health, or psychology). To increase effectiveness, health literacy courses should be adapted according to the different needs and characteristics of the student subgroups.

Keywords: health literacy, university students, health-promoting universities, systematic review, determinants of health behavior

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INTRODUCTION

University students worldwide experience a high level of psychological stress that exceeds the level of non-students and physiological and psychological health problems (1, 2). The reasons for this are academic responsibilities, financial worries, and adaptation to new life circumstances. These conditions can harm the health of the students (2, 3). To counteract this, the Okanagan Charter for health-promoting universities and colleges (4) was created. Educational institutions that follow the idea of the charter, create campus cultures of wellbeing, equity, social justice, and improve the health of the people who live, learn, and work there. Furthermore, they also strengthen the ecological, social, and economic sustainability of their communities and the society as a whole, considering the responsibility students will later bear in their given environment.

It is important to stress that if people have to achieve their full health potential, they must also take control of its determinants (5). Health promotion is therefore defined by the Ottawa Charter

(6) as a process that enables people to better control and promote their health on their own. This idea of empowerment can among other things be accomplished through the improvement of health literacy. The approach of promoting health literacy is indeed deeply rooted in health promotion *per se*: to empower people in a setting to make better decisions about their health and lives in general. A review showed that low health literacy is associated with poorer ability to understand and follow medical advice, poorer health outcomes, and differential use of some healthcare services (7). Educational institutions, such as universities, have the opportunity to optimize the health literacy of their students and empower them to make informed decisions for themselves and their environment (8).

According to Nutbeam (9), health literacy can be divided into three levels: functional, interactive, and critical health literacy. All three levels together comprise complex skills that enable an individual to extract, evaluate, and apply health-related information. Since the WHO introduced the concept of health literacy internationally in the glossary of health promotion (10), more and more definitions have been developed. Parker (11) defines health literacy as a relational concept that, while dependent on individual skills and abilities of a person, is also determined by the demands and complexity of health information and tasks. The most commonly used definitions of health literacy have been compiled by Sørensen et al. (12). In summary, all definitions address the importance of cognitive skills and competent skills that enable obtaining, understanding, and using health information.

There are a variety of reviews on health literacy in diverse populations and professional groups, such as men (13), older adults (14), immigrants (15), and librarians (16). The aim of this systematic review was to provide an overview of cross-sectional studies that examined health literacy among university students and to identify possible determinants. Additionally, we aimed to find out which theoretical frameworks and which different scales were used. Accordingly, the purpose of this review is 2-fold. First, we want to assess the state of research in this field and, second, we intend to identify starting points for decision-makers and health promoters at universities implementing health literacy interventions and adapting them to the needs of the target group.

With the specific target group of students, digital media should be highlighted as an especially relevant source of information, such as health information (17). However, skills required to collect information via the internet differ from those required to collect information from print media, e.g., books (18). Therefore, the definition of eHealth literacy will also be taken into account for this systematic review. It combines health literacy with media and computer-related skills (19).

METHODS

For the purpose of this systematic review, we followed the guidelines described in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (20). A review protocol has been prepared and can be requested from the authors. The study characteristics used to decide whether a study was eligible for inclusion in the review can be found below: cross-sectional studies (study design) examining the health literacy (outcome) of students in tertiary education of any age (population) and published since the publication of the Okanagan-Charter in 2015 were included in the review. No health status restrictions were imposed. The outcome variables of interest are health literacy and related influencing factors. The health literacy definition of Nutbeam (9, 21) and common health literacy definitions (12) were used as a guiding principle in that respect. Regarding eHealth literacy, the definition of Norman and Skinner (19) served as a decisive criterion. In the studies, the outcome variables had to be given either as primary or secondary outcome variables. Studies were identified by searching three electronic databases (PubMed, Scopus, and Web of Science). The last search was run on February 19, 2020. Additionally, at the end of the search process, the already qualified studies were checked for additional relevant references. Combinations of the following keywords were used to search the databases: university; college; students; adolescents; health literacy; eHealth literacy. The search term was based on the review of Chesser et al. (22), which has a comparable research question but with regard to a different target population. Studies published in English and German were considered for this review. The complete search query can be found in the **Appendix** (see **"Search term"**). The selection process (title, abstract, and full text) of the studies was conducted by two authors.

A data extraction sheet based on the patient/population, intervention, comparison and outcomes (PICOS) model was used to extract the desired data. Data items were [1] study-relevant information consisting of the name of the study, corresponding authors, the year of publication, and the country, [2] characteristics of participants (e.g., age, gender, study program, and course of studies), the underlying setting (university, college), [3] information on the outcome variables consisting of the theoretical background and the assessment instruments used, and [4] information on the results of the study regarding the health literacy of students and its determinants. The data extraction was always performed independently by at least two authors. Any discrepancies between the authors were resolved through discussion until consensus was reached.

The Appraisal Tool for Cross-Sectional Studies (AXIS) was used to assess the risk of bias of the included studies (23). Two authors independently assessed the quality of the studies. In case of disagreement, another author was consulted, and discussions were held until a consensus was reached. A scoring method was adapted to quantify the risk of bias in individual studies (24, 25). According to this method, studies were categorized as very low risk of bias if they scored at least 19 of 20 questions correctly, as low risk of bias if they scored 17 or 18 out of 20 of the questions of the tool; as the moderate risk of bias if they scored 15 or 16 out of 20, and as high risk of bias if studies scored 14 or fewer points.

The narrative synthesis was based on data synthesis guidelines (26). First, a preliminary synthesis was developed, including initial descriptions of the results of the studies used, grouping the studies according to the PICOS scheme, preparing data and putting them into a common descriptive format, and identifying patterns along with the studies. Subsequently, relationships of

the data within and between the studies were investigated. Overall health literacy, various factors that could contribute to health literacy and limitations and practical implications were identified. Also, plausible explanations were developed for the differences found within (characteristics) and between (results) the studies.

RESULTS

The search in the databases PubMed, Scopus, and Web of Science resulted in a total of 7,529 hits with the selected search terms. Out of those, 7,139 studies were excluded due to an inappropriate title, indicating an obviously different topic. Another 314 studies were excluded after the abstract review because they did not meet the necessary inclusion criteria. Thirteen further studies were removed after testing for duplicates. The full texts of the remaining 63 studies were then reviewed in detail. Forty-four of these did not meet the specified inclusion criteria. The remaining 19 studies were deemed suitable for inclusion in the review. In addition, further two studies could be identified by searching the references of these studies. Thus, a total of 21 studies were finally included in the review. **Figure 1** presents a flow diagram summarizing the selection process.

Seventeen studies were published in English and four in German. Studies had been conducted in Taiwan, Jordan, Denmark, the United States of America, Laos, Germany, Iran, Nepal, Portugal, Australia, Singapore, Lithuania, China, and Turkey. The selected studies were published in the period from 2015 to 2019. The included studies involved 13,772 students in higher education settings with the smallest sample size of 37 students and the biggest sample size of 2,892 students. The mean age of the students ranged from 20.1 to 24.1 years for the studies where data were available. Regarding student groups, twelve studies included students from various study programs, seven studies included students from various health-related study programs, and two studies included only one specific health-related program. Of the included studies, 17 were conducted in universities and two in colleges. Two studies provided no information about the setting. Theoretical frameworks for health literacy were the definition of the WHO (10), Nutbeam (21), Sørensen et al. (12), Baker (27), Kickbusch and Maag (28), Kickbusch, Maag, and Wait (29), Paasche-Orlow and Wolf (30), and Zarcadoolas, Pleasant, and Greer (31). Various scales were used to assess health literacy: The Turkey Health Literacy Scale (32), the Perception of Health Scale (33), the Health Literacy Questionnaire (34), the Danish version of the Health Literacy Questionnaire (35), concepts of Wieland and Hammes (36), Bässler (37), and Woll (38), the Iranian Health literacy questionnaire (39), the questionnaire of health-promoting lifestyle profile II (40), short version of the Test of Functional Health Literacy in Adults (S-TOFHLA) (41), the European Health Literacy Survey Questionnaire (HLS-EU)-Q16 (42), the HLS-Asia questionnaire (43), the HLS-EU-Portugal (PT) (44), The eHealth Literacy Scale (eHEALS) (45), the Taiwanese eHealth literacy scale (46), the dietary behaviors scale (47), and several self-made scales. With the exception of the performance-based S-TOFHLA (41), and a performance-based interview used by Kushalnagar et al. (48), these are all so-called self-reported health literacy instruments, i.e., instruments in which subjects are asked to self-assess their abilities (49). The survey instruments are largely based on rather broader definitions of health literacy and thus go beyond the functional aspect of it. The WHO definition is used as the theoretical basis in the Health Literacy Questionnaire (HLQ). The definition and model of Norman and Skinner (19) form the basis for eHEALS (45). Several different survey instruments are supported by the theoretical model of Sørensen et al. (12). The study by Kushalnagar et al. (48) also used its own survey instruments on the theoretical basis of Baker (27) and Nutbeam (21). Göring and Rudolph (50) assessed health literacy using a survey instrument based on the theory of Wieland and Hammes (36). The conceptual framework of the survey instrument used by Kaboudi et al. (51) was based on the theoretical considerations of Ratzan et al. (52).

In the study of Birimoglu and Cagalar (53), the health literacy of nursing students was insufficient compared to the data of other studies. Furthermore, working parents were associated with higher health literacy levels. Most students in the study by Budhathoki et al. (54) had only moderate health literacy and few individuals reported high health literacy according to their mean scores on the HLQ (34) scales. Thereby, higher age, being enrolled in a health-related course of study, higher educational level of parents, and male sex were associated with higher levels of health literacy. Elsborg et al. (55) showed that the health literacy scores of students were higher than the scores of the Danish population. Here, a higher study semester, female sex, being enrolled in a health-related course of studies, a higher educational level of the parents, and health-related experiences had a positive correlation with health literacy. The results of Göring and Rudolph (50) indicate that higher sports activity and male sex correlate positively with higher health literacy. Moreover, a finding of the study is that the mean health literacy values of common students are below the values of vocational school students. Kaboudi et al. (51) stated that in their study the mean and SD of the total health literacy of students were 4.04 ± 0.43 out of a score of five on the Iranian Health Literacy Questionnaire (39), indicating good health literacy. They found that healthy behavior is positively correlated with high health literacy. Due to their specific sample and measurement tools, Kushalnagar et al. (48) made no statement regarding the overall health literacy scores of deaf college students. The data showed a strong relationship between greater frequency of health-related discussions with friends and an accessible language during childhood and higher critical health literacy scores.

The results of Mullan et al. (56) suggest that different student groups have different health literacy profiles due to medical students demonstrating higher health literacy than students from other health-related courses of studies. Nevertheless, the authors conclude that students who are enrolled in a health-related course of studies, particularly nursing students, have gaps regarding their health literacy based on low to medium mean scores for the different HLQ (34) scales. Rababah et al. (57) also found limitations of health literacy among college students comparing

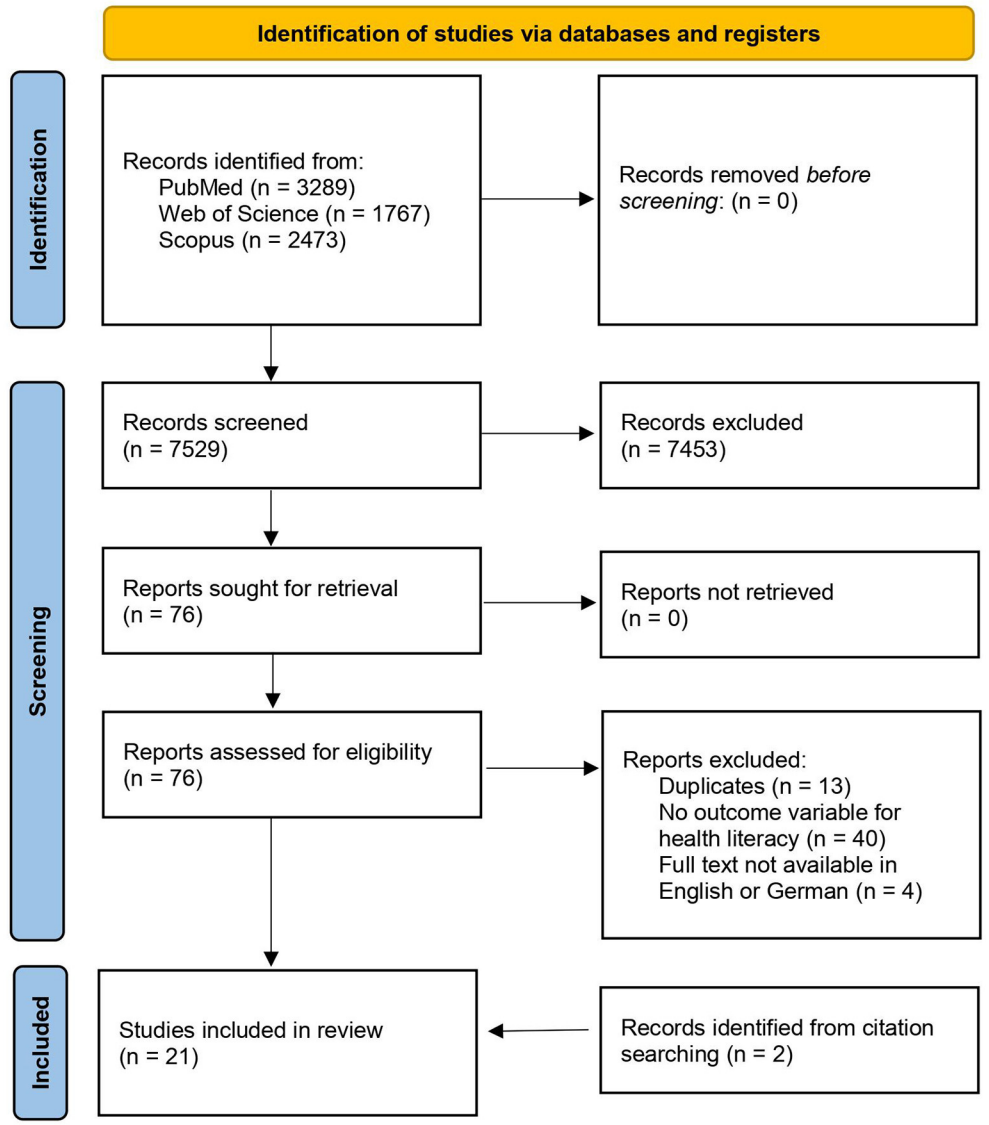

FIGURE 1 | Flow diagram.

the collected mean scores of the HLQ (34) to levels reported in the study of the measurement tool. Apart from the negative impact of smoking, health literacy was positively associated with higher age, higher study semester, female sex, and enrollment in a health-related course of studies. Compared with other population groups in Germany, there are more students with problematic health literacy according to Reick and Hering (58). Ninety-three percent of students in a study by Runk et al. (59) were found to have less than sufficient health literacy based on a reference index. According to the authors, accessible health services in the population and social understanding of health and disease and media distribution positively correlate with high health literacy levels. Santos et al. (60) made no statement regarding overall health literacy due to their specific research question, but found the internet as a poor source for information gathering among students. Compared to the adult population of North-Rhine-Westphalia and the German general population, students surveyed by Schricker et al. (61) have shown lower health literacy levels. While a higher subjective social status was positively correlated with the score, unfavorable financial situation and limited social support were negatively associated with health literacy by the authors. More than half of the students in the study by Schultes (62) have a high level of health literacy but are below the average in a European country comparison. Health-promoting behaviors of subjective health assessment and daily fruit and vegetable consumption were associated with better health literacy levels. The health literacy levels of the students in the study by Sukys et al. (63) were either lower, similar, or higher depending on international reference studies. A positive correlation with health literacy was found with the female sex and

with enrollment in health-related courses. Suri et al. (64) did not make a statement regarding general health literacy in their study. Their work focused on the influence of the type of information gathering (traditional sources vs. internet) on health literacy and underlines that different domain-specific health literacy skills for different health sources are needed. According to Vamos et al. (65), there is a gap in health literacy among the sample groups based on the mean scores for the different HLQ (34) domains. In their data, older age, female sex, higher parental education, and higher socioeconomic status are associated with higher health literacy levels.

The general student population in the study by Zhang et al. (66) achieved a mean score of 131.89 ± 18.84 to the overall score of 197.00 in the HLQ (34). In addition, the data indicate that the health literacy levels of the medical students are insufficient. According to the authors, higher study semester, course of studies (engineering), higher educational level of the parents, and higher socioeconomic status are positively correlated with health literacy, while depression and anxiety disorders are negatively correlated. Zou et al. (67) described in their study that the health literacy level of the student group examined is suboptimal compared to other studies. Thereby, a higher study semester, a higher educational level of the parents, and a higher socio-economic status were associated with better health literacy levels. Yang et al. (68) made no statement regarding overall eHealth literacy but found that a medical course of study resulted in higher levels. Regarding critical eHealth literacy, a positive, health-promoting behavior was positively correlated. In the study by Luo et al. (69), eHealth literacy levels of students were medium to high due to the collected mean scores of 3.66 ± 0.70 for functional eHealth literacy, 3.67 ± 0.67 for interactive eHealth literacy, and 3.65 ± 0.69 for critical eHealth literacy each with a maximum score of five with eHEALS (45). Positive correlation for functional eHealth literacy was found with high frequency in the use of medical services, for interactive eHealth literacy with the selection of suitable types and locations and low intervals of health services utilization and for critical eHealth literacy with the selection of suitable types, locations, and purpose aspects of health services utilization. Medium-to-high levels of eHealth literacy for the student sample were described in the study by Yang et al. (70) indicated through the mean scores of functional eHealth literacy with 3.56 ± 0.77, interactive eHealth literacy with 3.57 ± 0.71, and critical eHealth literacy with 3.59 ± 0.72 out of a maximum score of five with the eHEALS measurement tool (45). Additionally, functional eHealth literacy was negatively related to unhealthy food intake, interactive eHealth literacy was positively related to a balanced diet, and critical eHealth literacy was positively related to regular eating habits. Also, interactive eHealth literacy and critical eHealth literacy were positively correlated with positive attitudes and decisions about food purchasing. **Table 1** presents the results regarding the general levels of health literacy and possible determinants of these.

To compile and interpret the results of the studies in a meaningful way, it is important to consider differences and similarities, especially in terms of the methods used. As these are exclusively cross-sectional studies, all studies are relatively homogeneous regarding study design. The greatest differences can be found in the selected samples (several health-related courses of study vs. one specifically health-related course of study vs. various courses of study and number of semesters) and the measuring instrument used. The results of the examined studies show a relatively homogeneous picture regarding their data on the health literacy of students. Eleven studies (50, 53, 54, 56–59, 61, 65–67) report poor values or limited health literacy among students. A total of 8,089 students were involved in these studies. Regarding the study course, there is an even distribution between explicitly health-related and various study programs. Five studies include several health-related and five studies include all study programs. Only one study focuses on undergraduate nursing students solely.

For five studies, information on the number of semesters was available. Two studies explicitly included all semesters and three focused on students at the beginning of their study careers. These distributions about the course of study and the number of semesters must be taken into account when considering the results. The measuring instruments used in the studies are all assessed as valid and reliable, except for Göring and Rudolph (50), who used a self-made measuring instrument. The measurement instruments used were considered valid and reliable if they were sophisticated health literacy measurement instruments (e.g., HLQ) that had been previously tested, piloted, and repeatedly published.

The statements made on the health literacy of students are justified in each study due to comparisons with other populations. In fact, only two studies (51, 55) report higher health literacy scores among students than among the national population. A total of 796 students were surveyed in the two studies with reliable and valid HLQ. It should be noted that these are exclusively health-related programs and therefore their results should be interpreted accordingly. The results of one of the studies were compared with the Danish rural population and the results of the second study with older studies and with a reference sample.

In the studies of Schultes (62) and Sukys et al. (63), no conclusion regarding the results was reached since the comparison with different reference samples brought different results. The long and the short form of the HLS-EU was used for measurement in both of these studies. In the study by Schultes (62), various bachelor's degree programs were included and in the study by Sukys et al. (63) different health study programs, except for medicine. In other three studies (48, 60, 64), no conclusion regarding general health literacy is given. Regarding eHealth literacy, authors of two studies (69, 70) speak of medium or higher scores based on a score of their measurement instrument, and the third study (68) made no statement regarding general eHealth literacy levels. It should be noted that these three studies were conducted by the same research team.

Quantifying the risk of bias of the included studies using the AXIS tool (see **Table 2**), seven studies were classified as very low risk of bias (54, 56, 57, 64, 66, 67, 69), 11 studies were classified as low risk of bias (48, 50, 51, 55, 58, 60, 61, 63, 65, 68, 70), two studies were classified as the moderate risk of bias (53, 59), and one study was classified as high risk of bias (62). In terms of quality, we are therefore dealing with a

TABLE 1 | Results of individual studies.

Reference	Participants Gender Mean age	Facilities	Theoretical frame(s)	Scales used	Possible determinants[a]
Suri et al. (64)	1,062 students of all courses ♂46.3% ♀53.7% no mean age available (range: 18–38+)	Large University, Singapore	Zarcadoolas et al. (31)	Parts of HLQ[a], eHEALS[c]	**[+/-]** type of information gathering: traditional sources vs. internet (different domain-specific health literacy skills for different health sources)
Vamos et al. (65)	221 students from courses related to business administration, science and arts, nursing, education and human development ♂33.5% ♀66.5% 27 (median) (range: 15–30+)	University in southern Texas, USA	Kickbusch, Wait and Maag (29); Paasche-Orlow and Wolf (30); WHO (10); Sørensen et al. (12)	HLQ	**[+]** higher age **[+]** female gender **[+]** higher educational level of the parents **[+]** higher socioeconomic status
Zhang et al. (66)	1272 students of health-related courses ♂19.7% ♀80.3% 15 −19J.0 39.9%; 20.24 J. 59.9%, ab 25 J. 0.2% no mean age available (range: 15–30+)	Medical University in Chongqing, China	Sørensen et al. (12)	HLQ	**[+]** higher study semester **[+]** course of studies: engineering **[+]** higher educational level of the parents **[+]** higher socioeconomic status **[-]** depression / anxiety disorders
Elsborg et al. (55)	376 students of health-related courses ♂27.1% ♀72.9% no mean age available (range: 15–30+)	Several Universities in Denmark, Denmark	WHO (10); Sørensen et al. (12)	HLQ	**[+]** higher study semester **[+]** female Gender **[+]** course of studies: health-related **[+]** higher educational level of the parents **[+]** health-related experiences (e.g., hospital stay)
Kaboudi et al. (51)	420 students of health-related courses ♂47.6% ♀52.4% 22.50 (SD = 2.22)	Kermanshah University of Medical Sciences, Iran	Baker (27); WHO (10)	IHLQ[d], HPLP-II[e]	**[+]** health-promoting behavior
Mullan et al. (56)	371 students of health-related courses ♂36% ♀61% 25 (median)	University of Wollongong, Australia	Sørensen et al. (12); WHO (10); Nutbeam (21)	HLQ	**[+]**course of studies: medical students
Budhathoki et al. (54)	419 students of health-related courses ♂55.8% ♀44.2% no mean age available (range: 15–25+) (68.3% ≤ 19 *years*)	University: B.P. Koirala Institute of Health Sciences (BPKIHS), Nepal	Nutbeam (21)	HLQ	**[+]** higher age **[+]** course of studies: health-related **[+]** higher educational level of the parents **[+]** male gender
Zou et al. (67)	615 undergraduate nursing students ♂9.4% ♀90.6% no mean age available (range: 15–24)	Medical University in Chongqing, China	Baker (27); Nutbeam (21); Sørensen et al. (12)	HLQ	**[+]** higher study semester **[+]** higher educational level of the parents **[+]** higher socioeconomic status
Rababah et al. (57)	520 students of health-related and other courses ♂47.5% ♀52.5% 21.03 (SD = 2.29)	Jordan University of Science and Technology, Jordan	WHO (10); Sørensen et al. (12)	HLQ	**[+]** higher age **[+]** higher study semester **[+]** female gender **[+]** course of studies: health-related **[-]** smoking
Schultes (62)	533 bachelor students from four different courses of studies ♂29% ♀71% no mean age available (range: <19–29)	University of Applied Sciences, Hochschule Fulda, Germany	Kickbusch et al. (29)	HLS-EU-Q16[f]	**[+]** health-promoting behavior: Subjective health assessment **[+]** health-promoting behavior: Daily fruit and vegetable consumption
Runk et al. (59)	244 students from courses: environmental sciences and business administration and economics ♂39.3% ♀60.7% 19.7 (range: 17–29)	National University of Laos PDR, Laos	Nutbeam (21); Sørensen et al. (12);Zarcadoolas et al. (31); Zarcadoolas et al. (2003, 2005)	HLS-Asia[g]; interviews	**[+]** accessible health services in the population and social understanding of health and disease **[+]** media distribution
Sukys et al. (63)	912 students of all courses ♂63.3% ♀36.7% 21.08 (SD = 1.42)	Universities in Kaunas, Klaipeda and Vilnius, Lithuania	Sørensen et al. (12)	HLS-EU-Q47[h]	**[+]** female gender **[+]** enrollment in health-related courses
Reick and Hering (58)	127 students of health-related courses ♂7.9% ♀89.7% 24.1 (SD = 5.5)	University of Applied Science: Hochschule für Gesundheit Bochum, Germany	Sørensen et al. (12)	HLS-EU-Q16	None

(Continued)

TABLE 1 | Continued

Reference	Participants Gender Mean age	Facilities	Theoretical frame(s)	Scales used	Possible determinants[a]
Santos et al. (60)	485 students of all courses ♂22.5% ♀77.5% 23 (median)	University of Porto, Portugal	Nutbeam (21); Sørensen et al. (12)	HLS-EU-PT[i]	**[-]** using internet for information gathering
Birimoglu and Cagalar (53)	409 nursing students ♂37.7% ♀62.3% 20.81 (SD = 2.1)	University in Hatay, Turkey	WHO (10); Sørensen et al. (12)	THLS-32[j]; PHS[k]	**[+]** working parents
Schricker et al. (61)	996 students of all courses ♂30.1% ♀69.8% 22.80 (SD = 3.09)	TU Dortmund University, Germany	Sørensen et al. (12)	HLS-EU-Q16	**[+]** higher subjective social status **[-]** unfavorable financial situation **[-]** limited social support
Yang et al. (68)	556 college students of all courses ♂19.1% ♀80.9% age: no data	14 Colleges in Taiwan	Nutbeam (21)	eHEALS; HPLS[l]	**[+]** course of studies: medical (only in terms of ehealth literacy) **[+]** positive, health-promoting behavior (only in terms of critical ehealth literacy)
Luo et al. (69)	489 college students of all courses ♂37.4% ♀62.6% 21.51 (SD = 4.11)	9 Colleges in Taiwan	Nutbeam (21)	eHEALS; HSUS[m]	**[+]** high frequency in the use of medical services (only in terms of functional ehealth literacy) **[+]** selection of suitable types and locations and low interval of health services utilization (only in terms of interactive ehealth literacy) **[+]** selection of suitable types, locations and purpose aspects of health services utilization (only in terms of critical ehealth literacy)
Yang et al. (70)	813 college students of all courses ♂52.9% ♀47.1% 20.08 (SD = 1.43)	10 Colleges in Taiwan	Nutbeam (21)	eHEALS; DBS[n]	**[+]** less intake of unhealthy food (only in terms of functional ehealth literacy) **[+]** balanced diet and health aspects of consumers' nutritional behavior (only in terms of interactive ehealth literacy) **[+]** regular eating habits and consumer health (only in terms of critical ehealth literacy)
Göring and Rudolph (50)	2892 students of all courses ♂34.5% ♀65.5% 23.4 (SD/range: no data)	Georg-August-University Göttingen, Germany	WHO (10); Nutbeam (21); Kickbusch and Maag (28)	GKF[o]; typification of sports activity Bässler (37) and Woll (38)	**[+]** higher sports activity **[+]** male gender
Kushalnagar et al. (48)	37 deaf undergraduate college students of all courses ♂45.9% ♀54.1% 22.38 (SD = 2.68)	American college(s), USA	Nutbeam (21); Sørensen et al. (12)	S-TOFHLA[p], self-developed instruments, interviews	**[+]** greater frequency of health-related discussions with friends (only in terms of critical health literacy) **[+]** accessible language during childhood (only in terms of critical health literacy)

[a] *"**[+]**": promoting determinant; **"[-]"**: inhibiting determinant.*
[b] *Health Literacy Questionnaire.*
[c] *eHealth Literacy Scale.*
[d] *Iranian Health Literacy Questionnaire.*
[e] *Questionnaire of health-promoting lifestyle profile II.*
[f] *Short form of the European Health Literacy Questionnaire (HLS-EU).*
[g] *Health Literacy Survey Asia: Version of the HLS-EU for Asia and the Pacific.*
[h] *European Health Literacy Questionnaire (HLS-EU).*
[i] *Portuguese version of the HLS-EU.*
[j] *Turkish version of the HLS-EU: Turkey Health Literacy Scale (THLS-32).*
[k] *Perception of Health Scale (PHS).*
[l] *Health-promoting Lifestyle Scale.*
[m] *Health Services Utilization Scale.*
[n] *Dietary Behaviors Scale.*
[o] *Questionnaire for Health Literacy Expectation (german): Fragebogen zur Gesundheitskompetenzerwartung (GKF), Wieland and Hammes (36).*
[p] *Short Test of Functional Health Literacy in Adults.*
♂ = male sex; ♀ = female sex.

comparatively solid and homogeneous study situation, with only three out of 21 studies falling short. The main weaknesses of the included studies were the lack of sample size justification and not addressing non-responders.

Possible Determinants of Health Literacy

Among the determinants presented, there was strong evidence for a relationship between health literacy and age, the semester of study, gender, course of studies, parental education, and socioeconomic background. Other possible determinants could be accessed to information, health-related experiences, financial situation, social support, housing situation, physical activity, smoking status, symptoms of depression and anxiety disorders, employment status of parents, and daily fruit and vegetable consumption. For students with impaired hearing or deafness, the frequency of health-related discussions with friends and access to a language in childhood play a critical role. Electronic health literacy may be related to a medical degree course. There are also several determinants for the respective sublevels of eHealth literacy. With regard to the length of this section, the methodology and conduct of individual studies are only discussed, if they involve a special sample or use a debatable measuring instrument.

Age

Better health literacy with increasing age is shown in three studies (54, 57, 65) with 1,160 students overall, of which 419 come from health professional training programs (54). This correlation can be explained by increased experience with the healthcare system. With increasing age and experience, older students have an advanced ability to navigate within the healthcare system and engage with healthcare professionals. This results in increased awareness of health promotion resources in their environment and greater self-confidence when talking to healthcare professionals (54, 65). One study with 127 students found no correlation between health literacy and age (58).

Gender

In terms of gender, there were four studies (55, 57, 63, 65) with a total of 2,029 participants that measured higher health literacy among female students and two studies (50, 54) with a total of 3,311 participants that measured higher health literacy among male students, whereby it should be mentioned that Göring and Rudolph (50) used a self-made measuring instrument. Except for two studies (54, 55), these results refer to various study programs. These differences can be explained by variations in the educational system on the one hand, and sociocultural influences on the other (55, 57). For example, in predominantly patriarchal societies, women have less influence on household decision-making. Also, male children are preferred to female children because of the idea that boys need more knowledge and therefore should be able to maintain their health (54). Another explanation could also be that women assess the individual ability to influence subjective health in a different way than men. For example, a different perception of complaints and specifically female complaints can influence one's own self-efficacy expectations regarding one's health in a different way to men (50). Two studies with 1,123 participants, however (58, 61), could not find any differences between genders.

The Course of Studies

Six studies with a total of 3,873 students overall describe different levels of health literacy concerning the course of studies (54–57, 63, 66). Except for Rababah et al. (57), these results were found in studies that compared health-related courses of study. The results must, therefore, be interpreted carefully. These results can be explained by the specificity in certain health-related curricula. The contents of multiple health-related courses of study usually cover different areas of health promotion and disease prevention and individual political and organizational health areas. Students in health settings overall have better access to and understanding of health-related information, which facilitates decision-making and application of the decision. Besides, students in health-related courses of study often have a personal interest in the context of health promotion and the associated competencies due to their choice of study (54, 55, 63).

Study Semester

As the number of semesters of health students increases, so do the values of health literacy according to four studies (55, 57, 66, 67) with a total of 2,783 participants. This supports the assumption that in addition to personal motivation, the curriculum has a major influence on acquiring skills and knowledge related to one's health. As the semester increases, so does the knowledge obtained. Late semesters already have more medical expertise and know-how to obtain quality information (55, 66, 67). One study with 127 students found no correlation regarding this determinant (58).

Parental Education

Five studies including a total of 2,903 students recorded higher health literacy if their parents have received higher education (54, 55, 65–67). Except for Vamos et al. (65), this concerns students from several health-related courses. Possible explanations could be the increased health awareness of the parents due to their education, which enables them to navigate their children through the health system and rubs off on the children (54, 55, 65–67). One study with 127 participants found no correlation between the education of parents and the health literacy of students (58).

Socioeconomic Background

Three studies including a total of 2,108 students found that higher socioeconomic groups have better access, understanding, and handling of health-related resources (65–67). Within this result, all three forms of existing samples are present (several health-related courses of study, one specifically health-related course of study, various courses of study, and the number of semesters). Due to their higher socioeconomic status, students are more likely to be exposed to or have access to relevant information from parents and other health promotion resources. Here too, parents play a decisive role, since the socioeconomic status of students reflects the socioeconomic status of their parents (65, 67).

TABLE 2 | Quality assessment of the included studies.

	Kushalnagar et al. (48)	Göring and Rudolph (50)	Kaboudi et al. (51)	Birimoglu Okuyan and Caglar (53)	Budhathoki et al. (54)	Elsborg et al. (55)	Mullan et al. (56)	Rababah et al. (57)	Reick and Hering (58)	Runk et al. (59)	Santos et al. (60)	Schricker et al. (61)	Schultes (62)	Sukys et al. (63)	Suri et al. (64)	Vamos et al. (65)	Zhang et al. (66)	Zou et al. (67)	Yang et al. (68)	Luo et al. (69)	Yang et al. (70)
Q1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q3	0	0	1	0	1	0	1	1	0	0	1	0	1	0	1	1	1	1	0	1	0
Q4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q7	0	1	0	0	1	0	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1
Q8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q10	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Q11	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Q12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q13	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1
Q14	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Q15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q16	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Q17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q18	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Q19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q20	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1
Score	**17**	**18**	**18**	**16**	**19**	**17**	**19**	**19**	**17**	**16**	**18**	**18**	**14**	**18**	**19**	**18**	**19**	**19**	**18**	**19**	**18**

1, criterion met; 0, criterion not met.

Access to Information

One study (60) with 485 students from all courses of the study found that while the internet is the most popular way for students to access information, it is also associated with the worst health literacy scores (compared to those, who appeal to family and friends or specialty journals as a source of health information). This is most likely due to the quality of information available on the internet. Information on the internet is often incorrect and hardly comprehendible.

Health-Related Experiences

According to one study (55) with a sample size of 376 participants, students in health-related programs who have already gained experience in healthcare (e.g., hospitalization) have better health literacy. The reason for this is the experience they have already had and the support they receive from healthcare providers and their assessment of their ability to find health-related information and communicate with healthcare professionals.

Physical Activity

Regarding physical activity, one study including 2,892 students (50) from various courses of study reports a positive relationship between health literacy and sporting activity due to increased self-efficacy expectations, measured with a self-made measuring instrument. One study with 533 students (62) also from various courses of study, on the other hand, does not report any correlation, this being the study with a high risk of bias.

Various other determinants of health literacy for several health-related and various courses of study were discussed in the involved studies: better financial situation (61) and positively perceived health behavior (62), non-smoking status (57), symptoms of depression and anxiety disorders (66), and daily consumption of fruits and vegetables (62). Social support should also be mentioned, as social exchange processes can lead to greater security in obtaining and handling health-related information (61). Lastly, the employment status of parents is of interest, as higher health literacy was found among students with working parents. This phenomenon could be explained by better access to technological resources (53).

No Influence on Health Literacy

In addition to the abovementioned missing correlations, no connection was found between health literacy and the migration background (61) or membership to a health profession (58). Contrary to another study (57), one study (62) found no correlation between higher levels of health literacy and smoking status and alcohol consumption. However, it should be noted that this is a study with a moderate risk of bias.

Special Student Groups

One study (48) measured health literacy in a group of 37 deaf students with the S-TOFHLA for functional literacy, two extra questions for interactive health literacy, and critical health literacy via the response to a self-made video. It was found that a higher frequency of health-related discussions significantly contributes to better critical health literacy. Language barriers can be avoided by healthy-literate peers who share a common language. The critical health literacy of deaf students was not influenced by the hearing ability of family members, so other social characteristics, such as the effort of the parents to communicate with the deaf individual, encourage participation in family discussions about health (48).

Possible Determinants of eHealth Literacy

Three studies (68–70) with a total of 1,858 students have specifically addressed determinants of eHealth. In each case, the different forms of health literacy, functional, interactive, and critical, were analyzed. According to Yang et al. (68), the only general determinant for higher eHealth literacy, in general, is belonging to a medical degree program.

Functional eHealth Literacy

In functional eHealth, a high frequency in the use of medical services was discovered. Poor understanding of medical care directions and poor problem-solving skills may lead to ineffective care and a lack of behavioral change when new information is available (69). However, a lower intake of unhealthy food could also be associated with higher functional eHealth literacy. Students are thus able to understand the risks associated with unhealthy food and can avoid its intake in everyday life (70).

Interactive eHealth Literacy

The selection of appropriate types and locations for health services and a low frequency of use of these have been measured at high interactive levels of eHealth literacy. Interactive eHealth literacy could help students to act independently, increase their motivation and self-confidence, thereby selecting appropriate types and locations for their health needs (69). It is also linked to a balanced diet and health aspects of consumers' dietary behaviors, as interactive eHealth literacy can lead to students actively participating in everyday activities and promoting healthy consumption patterns (70).

Critical eHealth Literacy

The highest level of eHealth literacy is linked to three possible determinants. First, the selection of appropriate types, locations, and purpose aspects of health services, as critical eHealth literacy allows individuals greater control over life events and situations, thus enabling them to evaluate health issues, as well as risks and benefits and advocate for themselves (69). Next comes regular eating habits and consumer health. By critically evaluating electronic health information, students can filter out the advantages and disadvantages of this information and apply them to their eating habits and activities (70). Finally, positive, health-promoting behaviors are associated with higher critical eHealth literacy. Through the highest level of eHealth literacy, students can engage in health-enhancing actions through critical examination and advocating for themselves, to engage in health-enhancing actions (68).

No Influence on eHealth Literacy

No link to eHealth literacy was found in gender and frequency of consumption of organic food. As this is an educated and age-limited group, possible gender differences may have been

compensated (69). The frequency of organic food consumption is probably influenced more by perceptions of food safety than by knowledge about the food itself. Various food incidents worldwide may be the primary decision maker regardless of the level of eHealth literacy (68).

DISCUSSION

The general level of health literacy among university students seems to be insufficient and needs to be improved. Regarding the distribution of study courses, this observation seems to apply to both health-related and other study courses–although students from health-related study programs tend to have better health literacy. The health literacy of students is influenced by different variables. In this review, strong evidence for a relationship between health literacy and age, gender, number of semesters, course of studies, parental education, and socioeconomic background was found. These assumptions must be considered with regard to the respective samples selected. For example, regarding age and gender, more studies were represented with a general sample of students, while in course of study and parental education, more studies were represented with a sample of students studying health-related subjects. Concerning the number of semesters, only students from the health sector were represented, while concerning the socioeconomic background the distribution of students was equal among all sample types.

Students can benefit from increased health literacy for their own health. In addition to the personal added value, a social benefit can arise from health-competent multipliers in responsible positions. Besides, the results should always be considered in the context of the country's existing health system and social conception of health. Particularly concerning the results of gender differences, the cultural context must be considered. Health literacy can therefore possibly only be compared between populations if social, economic, and health systems are congruent (59). In general, however, it is recommended that universities pay more attention to the promotion of health literacy when planning the curriculum or additional offers for students. Electronic health literacy levels among students were high in the studies presented. However, this result should be interpreted with caution, as all three studies involved were conducted in the same country and possibly the same colleges and contradict the results regarding normal health literacy. A review (71) with six peer-reviewed articles and one doctoral dissertation with numbers of participants ranging from 34 to 5,030 on eHealth literacy also speaks of a high level of connection to the internet among students, but also of limited eHealth literacy. As the internet is the preferred way to obtain health information even if it does not lead to better health literacy or eHealth literacy, work is needed to promote the quality of the information and the ability of students to evaluate it (60). While the results of this review must be considered carefully, they can be used as a starting point for planning interventions and monitoring health literacy among students over the long term.

Concerning the studies, limitations in the performance of the measurements and the tests used were discovered. During the data collection process, practicability was prioritized, which meant that precision and quality had to suffer. This includes the use of incomplete questionnaires (70), or the inability to secure an appropriate, private space to take measurements (57). There were also limitations in the distribution of questionnaires. The use of social media can lead to self-selection bias and a lack of control over appropriate data (55). The self-reporting method may influence the accuracy of the results and the use of e-mail and online surveys may exclude students with low affinity to the internet (51). Some of the tests used had little or no evidence of their reliability or validity. A comparison between and within the studies is also difficult, because on the one hand HLQ-scores, for example, may not be comparable due to some scales being harder to score on (56), on the other hand, some studies used the long and other studies the more roughly measuring short form of their used test (e.g., HLS-EU-Q16 and HLS-EU-Q47). When using vignettes, participants may indicate what they think they have to indicate rather than giving their honest opinion (59). Another limitation was the exclusion of international students due to a language barrier.

The results of the study cannot readily be generalized, and its interpretation should only be applied to the respective groups of students. The reasons for this are the differences between the selected samples and the selected variables studied. For example, among the included studies there was often an uneven distribution in terms of gender or number of semesters. It should also be highlighted that some studies have examined students from various study programs and others only medical or health students. Due to a lack of time and money, very little information about the students was collected mostly. There may be other mediating or confounding variables that affect health literacy.

Also, this review is not without limitations. Overall, the quality of the included studies is sound. Nevertheless, there are three studies with moderate-to-poor study quality among them, and the majority of the high-quality studies lack sample size justification and addressing of non-responders as well. Differences regarding assessment methods, study population, and sample size hamper the comparison between the studies. Finally, it should be mentioned that only German and English language studies, and studies that have already been published or were available, were considered in this review.

Implications for Practice

Health literacy activities should target all students. Universities should make use of their resources and offer health literacy courses for students in which content is used from disciplines available at the university (e.g., medicine, health, or psychology). Multisectoral and multidisciplinary efforts are essential in promoting health for students, since not only synergies with regard to knowledge and resources are enabled, but also access to certain student subpopulations are made possible (72). To increase effectiveness, health literacy courses should be adapted according to the different needs and characteristics of the student subgroups and should be linked to evaluative research. The internet as well as gamification approaches, in particular, can help to make interventions interesting for the selected target group. Besides, social networks can provide an easy way to reach and

connect students to promote their health and eHealth literacy, why peer-to-peer programs could play a role in this context. To consider special groups of students (e.g., deaf students), care should always be taken to include a suitable form of language or exchange with health literate, accessible peers in the interventions (48). Additionally, consideration should be given to the planning process when cross-curricular activities are offered for students with different backgrounds and courses of study. When planning interventions according to specific areas of health literacy, different needs of student groups can be taken into account. Furthermore, a central website of the university could be used to communicate accurate and actionable health-related information in a way that is appropriate for the target group, as has already been done during the corona pandemic through the development of corona landing pages for students with frequently asked questions.

Implications for Research

The results of this review suggest that students are a relevant target group for future health literacy studies. Furthermore, there is a need for appropriate measurement methods in the university setting that reflects the circumstances of the living situation for students. Additional variables (e.g., structural aspects, such as support services provided by the university) that may be possible determinants of student health literacy should be collected. Once interventions have been designed, they can be examined to determine which methods and media (despite the challenge of the fast-changing digital environment) are most effective and which determinants in the cultural and social context require particular attention. To ensure that interventions are accessible to all students on campus, more research is needed on accessibility and effectiveness for specific student groups. Appropriate tools must also be developed to regularly check the quality of information available online to counteract misinformation.

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.

AUTHOR CONTRIBUTIONS

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

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APPENDIX

Search Term

(college OR "college students" OR university OR universities OR student OR students OR "young adult" OR "young adults" OR adolescent OR adolescents) AND ("critical health literacy" OR "health literacy" OR "eHealth literacy" OR "functional health literacy" OR "health-related literacy" OR "health literacy education" OR "literacy programs").

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The Prevalence of Pharmacological Neuroenhancement Among University Students Before and During the COVID-19-Pandemic: Results of Three Consecutive Cross-Sectional Survey Studies in Germany

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Background: According to the literature, the conditions of studying and living as well as the psychological, social and health behavior-related variables, which were strongly related to pharmacological neuroenhancement (PN) before the pandemic, significantly changed during the pandemic. For this reason, it is expected that the prevalence of PN among university students is higher during the pandemic compared to before the pandemic. Therefore, the present study aimed to investigate and compare the prevalence of PN among university students before and during the COVID-19-pandemic.

Methods: Three online surveys assessing the 12-month prevalence of PN were conducted among university students at the University of Mainz, Germany. The first survey took place in summer term 2019 (before the pandemic), the second in summer term 2020 (during the first German lockdown), and the third in summer term 2021 (after the second German lockdown). Pearson's chi-square test was used to test whether the 12-month prevalence of PN differed significantly between the three surveys.

Results: The 12-month prevalence of PN was 10.4% in 2019, 11.3% in 2020, and 8.0% in 2021. Chi-square tests revealed no statistical difference in the prevalence of PN between 2019 and 2020. Overall, the use of PN was lower in 2021 compared to 2019 ($p < 0.0001$) as well as in comparison to 2020 ($p = 0.001$). Only the use of cannabis slightly increased from 2019 to 2020 (7.1 vs. 8.3%) and decreased in 2021 (5.4%). At all three time points, cannabis was the most commonly

used substance for the purpose of PN. Consequently, the results suggest that the prevalence of PN was highly intertwined with the prevalence of cannabis use for PN.

Discussion: The decrease in the prevalence of PN of around three percentage points in 2021 compared to the previous years was a surprising finding. It may be mainly due to the decrease in the prevalence of cannabis for the purpose of PN. However, the fairly high prevalence of PN of around 8% in 2021 is still an important finding that demonstrates that there is still an urgent need for prevention initiatives among university students to combat the use of PN.

Keywords: university, college, epidemiology, brain doping, neuroenhancement (NE)

INTRODUCTION

Pharmacological neuroenhancement (PN) is generally defined as the use of illicit or prescription drugs by healthy individuals for cognitive-enhancing purposes such as enhancing alertness, attention, concentration, memory, and mood (1, 2). Daubner et al. (3) give a more in-depth look at the development and discussion regarding the different, partly popular scientific terminology and paraphrases around PN. In western Europe and the United States, epidemiological studies showed that PN is prevalent specific occupational settings such as surgeons and economics (4–6) and in the general population (7–9). Furthermore, a considerable number of studies demonstrated the use of PN in the collective of university students. For example, as lifetime prevalence for PN, 7.8, 3.2, and 19.2% was reported among Swiss (10), Norwegian (11), and British (12) students. Using an indirect survey technique, Dietz et al. (13, 14) described estimates for the 12-month prevalence of PN between 12 and 20% among university students from Austria and Germany. These estimates varied between the different study disciplines. Moreover, within a comprehensive review and meta-analysis, Benson et al. (15) reported the 12-month prevalence for the use of prescription stimulants to lay between 5 and 35% among college students in the US, demonstrating considerable heterogeneity in the range of this prevalence.

From a public health point of view, the use of PN is seen critically because it appears to be associated with physiological and psychological side effects and increased mortality, can lead to addiction, and may provide a gateway for the use of other substances (16–21). Therefore, the need for prevention of PN has been underlined by several experts (3). In this context, university students were pointed out as a population of specific relevance, since university students are tomorrow's leaders, decision-makers, and parents. Consequently, health promotion and prevention in this collective would be sustainable and beneficial for the general society (22, 23). Aiming to develop and implement prevention strategies of PN among university students more specifically, Heller et al. (24) investigated potential sociodemographic and study-related risk groups as well as predictors of PN taking sociodemographic, psychological, study-related, general psychosocial factors, as well as health behavior-related variables into account. They concluded that specific health behavior variables such as physical activity or nutrition had the most decisive influence on the explained variance of PN, supporting the results of previous studies (13, 25). In addition, other studies identified psychological factors such as stress (26–28) and study-related psychosocial factors such as perceived academic benefits (29–32) being related to PN.

On January 7th, 2020, Chinese authorities identified a novel coronavirus (SARS-CoV-2). Due to the rapid increase in cases of the corresponding coronavirus disease 2019 (COVID-19) worldwide, the World Health Organization officially declared the spread of COVID-19 as a pandemic (33). In response to the pandemic, universities in Germany were closed in March 2020 aiming to positively influence the course of infection. The abrupt loss of personal contacts with peers and faculty, postponement of curricula, research, practical work, and exchange programs, profound changes regarding their financial and housing situation as well as the abrupt switch to online learning (34–36) happened with far-reaching consequences, not only for the education of students but also for their mental health, health behavior and social behavior. For example, using a longitudinal design, Werner et al. (37) showed that university students' levels of loneliness and depression, symptoms of anxiety, and somatic complaints increased during the pandemic, supporting the results of previous studies from the USA and China (38, 39). With regard to behavioral variables, Csépe et al. (40) concluded that social behavior (e.g., fear and adherence to rules) and health-related behavior (e.g., smoking, nutrition, and physical activity) of university students changed in a negative way during the pandemic (40).

In summary, many empirical studies showed that PN was prevalent among university students before the COVID-19-pandemic. Furthermore, a wide range of explanatory variables of PN were examined before the pandemic, ranging from psychological, social, study-related, and health behavioral variables. However, with regard to the prevalence of PN among university students during the pandemic, we are not aware of any internationally published article addressing this issue. Since the conditions of studying and living as well as the psychological, social, and health behavior-related variables, which were strongly related to PN before the pandemic, significantly changed during the pandemic, it is expected that the prevalence of PN among university students is higher during the pandemic compared to before the pandemic. Therefore, the present study aimed to

address this knowledge gap by investigating and comparing the prevalence of PN among university students before and during the COVID-19-pandemic.

METHODS

Three online surveys were conducted among university students at the University of Mainz, Germany, as part of the interdisciplinary research project Healthy Campus Mainz. The first survey took place in summer term 2019 between June and August (before the pandemic), the second in summer term 2020 in June (during the first German lockdown), and the third in summer term 2021 between June and August (after the second German lockdown). All three surveys followed the same procedure. Students were invited to participate *via* e-mail addressed to all registered students using the central student mailing list of the university. The questionnaire of the first (pre-pandemic) survey covered questions regarding sociodemographic data, health status, health behavior, and a wide range of potential determinants of health status and health behavior. More specific information concerning the survey procedure and the content of the first survey can be found elsewhere (41). The second and third (pandemic) survey contained additional specific questions with regard to the COVID-19-pandemic. Participation was voluntary and informed consent was obtained before participation. Study approval was obtained by the ethical committee of the Medical Association of Rhineland-Palatinate (No. 2019-14336) for the first study and the Institute of Psychology of the JGU for the second (No. 2020-JGU-psychEK-S008) and the third (2021-JGU-psychEK-S017) study.

PN was investigated in all surveys as part of the health behavior questions following the same methodical approach published for example, by Heller et al. (24) and others (4, 5). Accordingly, the translated question to assess the prevalence PN was: "Have you ever used the following substance/-s without medical necessity, for the purpose of enhancing your cognitive performance or to better handle your studies (not for reasons of enjoyment)?" The following illicit or prescription drugs could be selected via multiple-choice, and each with the scale "never," "within the last 30 days," "within the last 12 months," or "more than 12 months ago": methylphenidate (e.g., Ritalin®), amphetamine preparation (e.g., Adderall®), atomoxetine (e.g., Strattera®), modafinil (e.g., Provigil®), ecstasy, ephedrine, cocaine, illicit amphetamines (e.g., Speed), crystal meth, cannabis, and "other substances." To be able to investigate potential changes in the prevalence of PN over time, the 12-month prevalence (dichotomous: "yes"/"no") instead of the lifetime prevalence was used for all further analyses. Pearson's chi-square test was used to test whether the 12-month prevalence of PN differed significantly between the three surveys. The prevalence of PN is presented as proportion of "yes" in the analyzed sample. Descriptive variables of the three surveys are presented as means with standard deviations (SD) for continuous variables and as absolute and relative frequencies numbers and percentages for categorical variables.

RESULTS

After data cleaning, a total of $N = 4{,}351$ students participated in the 2019 survey, $N = 3{,}066$ students in the 2020 survey and $N = 1{,}438$ students in the 2021 survey. The samples of the three surveys were largely comparable with regard to gender, age, and study-related characteristics (**Table 1**). The specific question with regard to the prevalence of PN was answered by $N = 3{,}984$ students in 2019, $N = 2{,}796$ students in 2020, and $N = 1{,}232$ students in 2021. The 12-month prevalence of PN was 10.4% in 2019, 11.3% in 2020, and 8.0% in 2021 (**Table 2**). Chi-square tests revealed no statistical difference in the prevalence of PN between 2019 and 2020. Overall, the use of PN was lower in 2021 compared to 2019 ($p < 0.0001$) as well as in comparison to 2020 ($p = 0.001$). Taking a closer look at the specific substances used for the purpose of PN (**Table 3**), it can be seen that the 12-month-prevalence rates of all substances were relatively constant at the three time points. Only the use of cannabis slightly increased from 2019 to 2020 (7.1 vs. 8.3%) and decreased in 2021 (5.4%).

DISCUSSION

In the present study, we investigated whether the 12-month prevalence of PN among university students was higher during the COVID-19-pandemic compared to the prevalence before the pandemic. Therefore, three waves of survey in the summer terms of the respective years were conducted, one before the pandemic (2019), one during the first German lockdown (2020), and one after the second German lockdown (2021), when the infection case rates were continuously decreasing in Germany and lockdown measures were loosened. The sample sizes of the three surveys decreased from 2019 to 2020 and from 2020 to 2021. As we used the same methodological approach for recruiting university studens in all three surveys by contacting all students of the University of Mainz per E-Mail *via* a central mailing list (41), we do not think that the decrease in sample size had methodological reasons. However, we noticed (although empirical data are lacking for this hypothesis) an increase in "tiredness" of being online most time of the day for example for working, studying, and social interactions. Consequently, we hypothesize that the university students lost their motivation to participate in one more voluntary online survey during the pandemic what may be a reason for the decrease in sample size.

Contrary to our expectation, the prevalence of PN was relatively constant in 2019 and 2020 but decreased significantly in 2021. At all three time points, cannabis was the most commonly used substance for the purpose of PN, which made up around two-thirds to three-fourths of the total prevalence of PN at all measurement points. Consequently, the results suggest that the prevalence of PN was highly intertwined with the prevalence of cannabis use for PN.

The relatively constant or slightly increasing numbers from 2019 and 2020 are in line with the recently published drug survey 2021 of the federal government, indicating that the prevalence of the use of cannabis among young adults is continuously increasing since the last years (42). Furthermore, as stated in

TABLE 1 | Sample characteristics of the three surveys.

	2019 (pre-pandemic, *N* = 4,351)	2020 (during pandemic, *N* = 3,066)	2021 (during pandemic, *N* = 1,438)
Gender, *n* (%)	(*n* = 4,350)	(*n* = 3,066)	(*n* = 1,436)
Female	3,065 (70.4)	2,225 (72.6)	1,065 (74.2)
Male	1,246 (28.6)	821 (26.8)	338 (23.5)
Diverse	39 (0.9)	20 (0.7)	23 (2.3)
Age, years (mean ± SD)	16–73 (23.8 ± 4.4)	16–68 (23.4 ± 4.4)	16–69 (23.7 ± 4.7)
Semester (mean ± SD)	1–45 (7.1 ± 4.9)	1–35 (6.4 ± 4.5)	1–38 (6.5 ± 4.7)
Aspired degree, *n* (%)	(*n* = 4,351)	(*n* = 3,065)	(*n* = 1,436)
Bachelor	2,261 (52.0)	1,709 (55.8)	827 (57.6)
Master	920 (21.1)	645 (21.0)	269 (18.7)
State examination	977 (22.5)	662 (21.6)	317 (22.1)
Other	193 (4.4)	49 (1.6)	23 (1.6)
Field of study, *n* (%)	(*n* = 4,342)	(*n* = 3,012)	(*n* = 1,430)
STEM[a]	783 (18.0)	506 (16.8)	217 (15.2)
Social sciences, media or sport	774 (17.8)	493 (16.4)	269 (18.8)
Linguistics, humanities, and cultural sciences	871 (20.1)	621 (20.6)	315 (22.0)
Medicine	582 (13.4)	341 (11.3)	211 (14.8)
Law and economics	576 (13.3)	479 (15.9)	156 (10.9)
Teaching	665 (15.3)	510 (16.9)	243 (16.9)
Other	91 (2.1)	62 (2.1)	19 (1.3)

[a] *Science, Technology, Engineering, and Mathematics.*

TABLE 2 | Twelve-month prevalence of PN in the three surveys.

	2019 (pre-pandemic)	2020 (during pandemic)	2021 (during pandemic)
All participants, *n*	3,984	2,796	1,232
12-month prevalence, *n (%)*	416 (10.4)	316 (11.3)	98 (8.0)

the world drug report 2021 of the United Nations, cannabis use patterns had remained relatively stable during the first lockdown period in the European Union, with nearly half of the participants reporting no change in their cannabis use, compared with the pre-lockdown period. In addition, as described in the second booklet on the global overview of drug demand and drug supply of the world drug report 2021, supply chains for Cannabis and also for other psychoactive substances were not affected by the pandemic. In the fifth booklet of this report on the impact of COVID-19 on drugs, it is further stated that COVID-19 may have accelerated the pre-existing trends toward increased use and availability of cannabis in some high-income countries as some people have turned to the drug to alleviate stress or manage boredom brought on by stay-at-home orders (43). However, these reports refer to the prevalence for the use of cannabis *per se* and not for the specific purpose of PN, as we did in our study. Therefore, the comparability of numbers has to be seen with caution.

The decrease in the prevalence of PN of around three percentage points in 2021 compared to the previous years was a surprising finding. It may be mainly due to the decrease in the prevalence of cannabis for the purpose of PN, which was also around three percentage points. In contrast, the prevalence for the other surveyed substances for PN remained the same. However, as literature regarding the prevalence of PN during the COVID-19-pandemic is rare, any discussion of this finding will be mostly hypothetical. One reasoning could be that potential demands (e.g., mental, social, and study-related) that were present during the lockdown and university closure period may have decreased after the end of the lockdown when infection case rates declined and restrictions were continuously loosened. In contrast to this reasoning, a study among college students performed at seven colleges in the United States showed that depressive symptoms and anger were modestly higher post-college closure compared to pre-college closure period, whereas no differences were observed in anxiety symptoms or insomnia and variables of cannabis use. However, the data were subject to both self-report and self-selection bias (44). One theoretical approach to explain the decrease of the prevalence of PN in 2021 could be Kahnemanns's Prospect Theory (45). According to this approach, the slightly higher prevalence of PN at the beginning of the pandemic (2020) could be explained by the situation and circumstances that students were confronted with, which were characterized by many uncertainties such as loss of personal contacts with peers and faculty, research, practical work, and exchange programs, profound changes regarding their financial and housing situation as well as the abrupt switch to online learning. These may have increased tendencies toward risk behaviors like PN. In contrast, the decreased prevalence of PN in 2021 reflects that the experiences after 1 year of studying under the conditions of the pandemic

TABLE 3 | Prevalences for the use of each specific illicit or prescription drug for PN in the three surveys ($N = 3,984$ in 2019; $N = 2,796$ in 2020; $N = 1,232$ in 2021).

	12-month prevalence for the use of specific substances for PN		
	2019 (pre-pandemic)	**2020 (during pandemic)**	**2021 (during pandemic)**
Prescription and illicit drugs			
Methylphenidate	1.4% ($n = 54$)	1.5% ($n = 46$)	1.4% ($n = 17$)
Amphetamine preparation	0.2% ($n = 7$)	0.3% ($n = 8$)	0.2% ($n = 3$)
Atomoxetine	0.2% ($n = 6$)	0.2% ($n = 5$)	0.2% ($n = 3$)
Modafinil	0.3% ($n = 13$)	0.2% ($n = 6$)	0.2% ($n = 3$)
Ecstasy (MDMA)	1.0% ($n = 38$)	0.8% ($n = 23$)	0.6% ($n = 8$)
Ephedrine	0.2% ($n = 8$)	0.1% ($n = 3$)	0.2% ($n = 3$)
Cocaine	0.6% ($n = 25$)	0.9% ($n = 25$)	0.6% ($n = 7$)
Amphetamine	0.9% ($n = 36$)	0.9% ($n = 25$)	0.6% ($n = 7$)
Crystal meth	0.1% ($n = 3$)	0.1% ($n = 4$)	0.0% ($n = 0$)
Cannabis	7.1% ($n = 284$)	8.3% ($n = 230$)	5.4% ($n = 67$)
Other substances	2.2% ($n = 91$)	2.8% ($n = 77$)	1.8% ($n = 22$)

may have given a certain kind of security to the students that studies can be handled and even solutions like online-exams may cause less stress and therefore less risk behviors like PN.

For a more in-depth interpretation of the present results, especially the decrease in the prevalence of PN in 2021 compared to the previous years, more studies are needed addressing the prevalence of PN among university students and potential explanatory variables of PN during the COVID-19-pandemic. Despite the necessity of further research, the fairly high prevalence of PN of around 8% is still an important finding that demonstrates that there is still an urgent need for prevention initiatives among university students to combat the use of PN. To be able to plan evidence-based and effective PN-prevention initiatives for university students, it is important to understand the conditions and factors predicting PN among this target group. In this context, using a stepwise binary logistic regression model, Heller et al. (24) showed that specific varibles of health behavior predicted the use of PN among university students indicating that initiatives strengthening health behavior may prevent PN. This is in line with other research indicating that strengthening health-related key skills and ressources (in the sense of positive coping strategies) leads to a decrease in the prevalence of PN. For example, Bagusat et al. (26) concluded that tailored resilience interventions that improve the ability to adapt to and recover from stressors prevent the use of PN. Consequently, we recommend that initiatives aiming to prevent PN among university students have to be multifactorial taking the specific conditons of studying into account and have to focus on strengthening competences with regard to health behavior, mental health literacy and non-pharmacological ressources and strategies (24, 46, 47). Especially during the COVID-19-pandemic and in times of distance-teaching, online programs are of particular relevance. To name just some concrete examples of evidence-based online intitiatives for university students, at the university of Mainz, Germany, *KEN-Online*, and *STUDYCoach* are programs where students learn to deal with, for example, their emotions, stress, or symptoms of depression or anxiety. Another approach which aims to transport the topics physical activity, sedentary behavior and digital detox into (online) lectures is the program called *Health Express*. Here, long lectures are interrupted by short video clips which address a specific health-related topic and which were specifically developed for the target group university students under participation of university students. Moving from sitting into standing position is obligatory at the beginning of all video clips (48).

As potential limitation, it has to be mentioned that no causal inference can be drawn from cross-sectional data, as performed in the present study.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Medical Association of Rhineland-Palatinate (No. 2019-14336) for the first study and the Institute of Psychology of the JGU for the second (No. 2020-JGU-psychEK-S008) and the third (2021-JGU-psychEK-S017) study. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

PD, AW, MS, JR, LM, and SH contributed in data collection. PD, AW, and SH contributed in data analysis. PD, PS, and SH contributed in interpretation of the results. PD had the lead in

manuscript writing. All authors have read and approved the final draft of the manuscript and contributed in conceptualization and study design.

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Physical Activity and Sedentary Behavior in University Students–The Role of Gender, Age, Field of Study, Targeted Degree, and Study Semester

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Background: Physical inactivity and sedentary behavior are modifiable risk factors for an unhealthy lifestyle in university students. The aim of this study was to identify subgroups among German university students with an increased risk for unhealthy behavior. For this purpose, differences in physical activity and sedentary behavior with respect to sociodemographic and study related factors were examined.

Methods: A total of 4,351 students participated in an online survey. The amount of physical activity (metabolic equivalent of task-min/week) and the sitting time (h/day) were assessed using the German short form of the International Physical Activity Questionnaire. Differences in gender and age as well as field of study, targeted degree and study semester were analyzed using a single factorial ANOVA with Tukey correction or a Welch-ANOVA with Games-Howell correction.

Results: For physical activity, significant differences were found for gender ($F_{(2,80.46)} = 17.79$, $p < 0.001$, $\eta p2 = 0.009$), for field of study ($F_{(5,1738.09)} = 7.41$, $p < 0.001$, $\eta p2 = 0.01$), and for study semester ($F_{(1,948.12)} = 5.53$, $p < 0.05$, $\eta p2 = 0.001$), but not for age and targeted degree ($p > 0.05$). For sedentary behavior, significant differences were found for field of study ($F_{(5,3816)} = 5.69$, $p < 0.001$, $\eta p2 = 0.01$) and targeted degree ($F_{(3,3868)} = 3.94$, $p < 0.01$, $\eta p2 = 0.003$), but not for gender, age and study semester ($p > 0.05$).

Conclusion: Female students, students enrolled in "natural sciences, mathematics and informatics" and first year students appear to have an increased risk of an unhealthy

lifestyle. Future research should identify barriers to and incentives of physical activity as well as reasons for high amounts of SB in sub-populations of university students. Suitable prevention and intervention programs are necessary.

Keywords: physical activity, sitting time, student health, modifiable health influencing factors, sedentary behavior, university students

INTRODUCTION

A conscious lifestyle can contribute to the long-term maintenance of health and wellbeing at any age. In this context, regular physical activity (PA) is a key factor preventing non-communicable diseases and primary causes of premature morbidity and mortality. Nevertheless, about 31 % of all adults worldwide are physically inactive, meaning they do not meet the minimum recommendation of PA consolidated by professional health societies like the World Health Organization (WHO) (1). The WHO classified physical inactivity as fourth leading risk factor for global mortality (2), not only negatively affecting the individual, but also representing a significant economic burden (3). To counteract the negative effects of physical inactivity and promote health, the WHO recommends at least 150 min of at least moderate or 75 min of vigorous physical activity per week, complemented by strength training twice a week (4–6). Regarding the total PA, which includes light-intensity PA like walking, the highest health-gains are reported to be occurring at 3,000 metabolic equivalent of task- (MET-) min/week (2, 7).

Regardless of the PA performed, sedentary behavior (SB) is another factor strongly influencing health and wellbeing. Tremblay (8) defines SB as activities with an energy expenditure below 1.5 MET, such as lying or sitting still, whereas physical inactivity means an insufficient amount of moderate to vigorous PA (MVPA). SB has become more and more prevalent in modern societies due to changes in the physical, social, and economic environments. Independent of but equal to PA, total sitting time is associated with a greater risk for several major chronic diseases and all-cause mortality (9–12). For an increased risk for all-cause and cardiovascular mortality, a threshold of 6 to 8 h/day of total sitting was identified (13, 14). A recent review reports that adults worldwide spend an average of 6.4 h per day sitting, ranging from 3.8 to 11.9 h (15). In comparison to that, objective measurement methods revealed even higher sitting times (median 8.2 h/day) than self-reported assessments (5.5 h/day) (15). A meta-analysis from Ekelund et al. (16) observed that about 1 h of MVPA per day is necessary to mitigate an increased all-cause mortality risk due to such high sitting time. Therefore, public health strategies have to focus on enhancing PA and prolonged SB simultaneously (17, 18).

The transition from school to university is a time that leads to changes in the home environment, work environment and leisure time. This change in living environment is often described as critical phase potentially vulnerable to risk behaviors, such as alcohol consumption and lack of physical activity (19, 20). Already as high school progresses, a significant decline of pupils meeting the minimum age-appropriate (5–17 years) recommendations for PA (60 min of MVPA per day) is evident (21). The situation is similar for university students, where only about 50 % achieved the recommendations for PA (22–25). Additionally, students' everyday life is characterized by sedentary activities (e.g., visiting lectures, classes and seminars, studying) (26–28). Therefore, it is not surprising, that the prevalence of SB appears to be much higher in university students than the global average (29). Regarding total SB, self-reported estimates across 32 studies indicate that university students spend on average 7.29 h per day sitting (30). During study semester, previous research found an increase of levels of PA (31, 32). In addition, SB is expected to increase as study progresses (30), which is consistent with the increase of weight and body fat percentage (33). However, health promotion in universities offers not only the opportunity to positively influence students' health behavior, but is also beneficial for general society since students are the leaders, decision-makers, and parents of tomorrow (34).

In order to promote health, it is necessary to identify potential health-related risk groups within the student population. In this context, the field of physical health is understudied (35). Moreover, the influence of study-related factors like study semester and major field of study on student health was either not investigated or yielded inconsistent results (30–32, 35).

Therefore, the aim of this study was (1) to assess the amount of PA and SB in German university students and (2) to identify subgroups in this population with increased risk for poor health. To identify potential health-related risk groups, differences in gender and age as well as study-related factors such as field of study, targeted degree and study semester were investigated.

MATERIALS AND METHODS

Study Design and Ethical Approval

In summer term 2019, a cross-sectional online survey was conducted as part of an ongoing evidence-based student health initiative at the Johannes Gutenberg-University of Mainz (JGU, Germany). It included around 270 items regarding important health-related factors from mostly validated standard instruments and partly self-constructed or adapted items. The web-based software Unipark (Tivian XI, Cologne, Germany) was used to design the questionnaire. Pre-tests were conducted to examine question presentation, completion time and question comprehension, resulting in minor adaptions of the questionnaire (36). The survey was online for 49 days and the students received 4 reminders during this period. The survey was approved by the local ethics committee of the Medical Association of Rhineland-Palatinate (application-number: 2019-14336). All participants provided digital informed consent. More in-depth information regarding the survey methodology

and the questionnaire is provided in the publication of Reichel et al. (36).

Participants

All students being enrolled in the summer term of 2019 in at least one subject at the JGU ($N = 31,213$) were invited to take part in the survey. The JGU is organized in ten faculties and additionally the Mainz School of Music and the Mainz Academy of Fine Arts. Study subjects range from law and economy over social- and natural sciences, humanities and medicine to music, fine arts and sport. All students received a link to the survey via the university mailing list. Monetary and non-monetary incentives were held out to increase motivation to participate.

Measures

The German short form of the International Physical Activity Questionnaire (IPAQ-SF) was used to assess the self-reported PA level and sitting time (37). The IPAQ is a reliable and valid tool (38, 39) and is suitable as well as recommended to assess the PA level among university students (40, 41). The questionnaire consists of seven questions, assessing the frequency (in number of days) and duration (minutes per day) spent for (1) vigorous-intensity activities, (2) moderate-intensity activities and (3) walking over the last seven days (42). Additionally, the time spent sitting on a weekday was assessed as an indicator for SB (42). The sums of (1) and (2) were cumulated to calculate the amount of MVPA in minutes per week.

In addition to the IPAQ-SF, the self-reported sociodemographic variables gender, age, as well as study related variables such as field of study, targeted degree and study semester were assessed to identify sub-groups for an inactive and sedentary lifestyle among university students.

Data Processing and Statistical Analyses

The predefined protocol from Cheng (43) was used to calculate the overall PA expressed in MET-minutes/week. According to the guidelines for data processing and analysis of the IPAQ-SF, questionnaires were considered invalid, if any variable was missing, or the total sum of walking, moderate and vigorous activity as well as the total sum of time spent sitting per day exceeded 960 min (16 h) (44). The collected data can be summarized as a continuous indicator for PA expressed in MET-minutes/week, commonly used to assess total PA (45). Therefore, the weekly time for moderate and vigorous activity as well as walking were computed by separately multiplying the minutes per day and the days per week. The calculated minutes per week for each category were multiplied by MET (expressed as MET-minutes per week) to weight each type of activity by its energy expenditure. Time spent in low-intensity activities, such as walking, is multiplied by 3.3, time spent in moderate-intensity activities are multiplied by 4, and time spent in high-intensity activities are multiplied by 8 (44).

The data on MVPA and vigorous intensity PA were used to ensure the fulfillment of the PA-recommendations of professional health associations and therefore classified as insufficiently, moderately or highly active (4, 46). On that account, individuals not meeting the minimal suggestions of at least 150 min of MVPA or 75 min of vigorous PA are classified as insufficiently active. Participants meeting the suggestions for additional health benefits of at least 300 min of MVPA or 150 min of vigorous PA are classified as highly active, while those only achieving the minimum requirements of PA being categorized as moderately active.

The reported time spent sitting per weekday in the last seven days is presented in minutes per day according to the predefined scoring protocol (44). Referring to current scientific findings of sitting 8 h per day being associated with significantly increased risk of mortality (13, 14, 16, 47), time spent sitting was dichotomized into sitting <8 h and sitting at least 8 h.

Participants were dichotomized by the median age value into those, who are maximal 23 years old and those being older. Based on BMI, all students were classified as underweight (BMI $<$ 18.5), normal weight (18.5 $\leq$ BMI $\leq$ 24.9), pre-obesity (25.0 $\leq$ BMI $\leq$ 29.9) and obesity (BMI $\geq$ 30) (48).

In accordance with previous studies (31, 49, 50) and the organization of the university in different faculties, students' field of study was allocated to the following groups: "natural sciences, mathematic and informatics," "social sciences, media and sport," "language, humanities and cultural studies," "medicine," "economics and law" and "education."

Statistical analyses were performed using SPSS version 23 (IBM, Chicago, IL, USA). Descriptive analysis of overall PA and the proportions of insufficiently, moderately and highly active participants as well as sitting time and proportions of sitting times of at least 8 h were computed for all participants, and separately for sociodemographic and study-related variables. To identify subgroups with increased risk for an unhealthy lifestyle, differences between gender, age groups, targeted degree, field of study and study semester were performed for mean values of PA (MET-minutes/week) and SB (minutes/day sitting). Homogeneity of variances was assessed using Levene's Test. If equal variances could be assumed, a single factorial ANOVA with Tukey correction was performed, otherwise a Welch-ANOVA with Games-Howell correction was carried out. The effect size was estimated by partial eta² ($\eta p2$) with $\eta p2 \geq 0.01$ indicating a small, $\eta p2 \geq 0.06$ a medium, and $\eta p2 \geq 0.14$ a large effect (51). Statistical significance was set at probability values <0.05 ($p < 0.05$).

RESULTS

Sample Characteristics

A total of 5,006 participants viewed the first page of the questionnaire. 4,714 students continued further. After a manual data cleaning according to predefined criteria, the final sample was 4,351, demonstrating a response rate of 13.9 % of the whole student body (36). After processing data on PA acording to the guidelines for data processing and analysis of the IPAQ-SF (44), 3,961 participants were included in this study. Demographic data on gender, age, and BMI, as well as targeted degree and study semester of all included students were shown in **Table 1**. The distribution of students on the field of study, overall and stratified by gender and study semester were shown in **Table 2**.

Physical Activity

Overall, 22.4 % of the sample were assigned as insufficiently active. Stratified by gender, 17.6 % of male, 24.2 % of female and 32.3 % of diverse students were insufficiently active. The median value of PA was 3,066 MET-minutes/week, with a first quartile at 1,704 MET-minutes/week. **Table 3** summarizes the descriptive data as well as the results of the ANOVA or Welch's Test. There were no significant differences between age ($F_{(1,3957)} = 0.51$, $p > 0.05$, $\eta p2 = 0.000$) and targeted degree ($F_{(3,609.91)} = 1.13$, $p > 0.05$, $\eta p2 = 0.001$).

With regard to gender differences, male students reported the highest and diverse students the lowest average PA values. The mean level of PA differs statistically significant for gender with small effect size ($F_{(2,80.46)} = 17.79$, $p < 0.001$, $\eta p2 = 0.009$). *Post-hoc* analysis revealed a significant difference between male and female students ($p < 0.001$) and between male and diverse students ($p < 0.05$), but not between female and diverse students ($p > 0.05$).

With regard to differences concerning field of study, students of natural "sciences, mathematics and informatics" (3,428 MET-min/week) and those of "languages, humanities and cultural studies" (3,553 MET-min/week) reported the lowest total PA. Students of social sciences, media and sports (3,844 MET-min/week), of medicine (3,981 MET-min/week) and those of education (4,312 MET-min/week) reported the highest total PA (**Table 3**). *Post-hoc* analyses revealed a significant difference between students enrolled in "natural sciences, mathematic and informatics" and those of "social sciences, media and sports" ($p < 0.05$), those of "medicine" ($p < 0.01$) and those of "education" ($p < 0.001$). In addition, a significant difference was found between students of "languages, humanities and cultural studies" and students of "education" ($p < 0.001$). Common to all fields of study, female students reported lower PA values than male students. The gender difference on PA was highest among those studying in the field of "education" (-1,107 MET-min/week) and lowest for students of "natural sciences, mathematic and informatics" (-144 MET-min/week).

With regard to study semester, first year students reported significant lower levels of PA than students of higher years with negligible effect ($F_{(1,948.12)} = 5.53$, $p < 0.05$, $\eta p2 = 0.001$) (**Table 3**).

TABLE 1 | Sample characteristics relating to gender, age, BMI, targeted degree and study semester.

Characteristics	Value
Gender, *N* (%)	3,961 (100)
Female *N* (%)	2,830 (71.4)
Male *N* (%)	1,100 (27.8)
Diverse *N* (%)	31 (0.8)
Age, *N* (%)	3,958 (99.9)
range, years (mean ± SD; Median)	16–73 (23.8 ± 4.3; 23.0)
BMI (mean ± SD), *N* = 3,928 (99.2%)	23.1 ± 4.2
Underweight, *N* (%)	235 (5.9)
Normal weight, *N* (%)	2,780 (70.2)
Pre-Obesity, *N* (%)	684 (17.3)
Overweight, *N* (%)	229 (5.8)
Targeted degree, *N* (%)	3,961 (100)
Bachelor	2,074 (52.4)
Master	842 (21.3)
State examination	869 (21.9)
Ph.D.	138 (3.5)
Study semester, *N* (%)	3,857 (97.4)
First year students, *N* (%)	639 (16.1)

Sedentary Behavior

The average self-reported sitting time of university students is 7h 25min, with 47.6 % of the students sitting at least 8h per weekday. **Table 4** summarizes the descriptive data as well as the results of the ANOVA or Welch's Test. There were no significant differences between age ($F_{(1,3608.01)} = 2.10$, $p > 0.05$, $\eta p2 = 0.001$), gender ($F_{(2,74.80)} = 0.48$, $p > 0.05$, $\eta p2 = 0.000$) and study semester ($F_{(1,3802)} = 0.49$, $p > 0.05$, $\eta p2 = 0.000$).

The self-reported time spent sitting differs significantly between the groups assigned according to the targeted degree with negligible effect size ($F_{(3,3868)} = 3.94$, $p < 0.01$, $\eta p2 = 0.003$). *Post-hoc* analysis revealed students targeting a bachelor's degree differed statistically significant from those targeting a Ph.D. ($p < 0.05$). Students targeting a Ph.D. reported the highest average sitting time of 7 h 56 min and highest prevalence (54.7 %) of sitting at least 8 h per weekday.

TABLE 2 | Sample characteristics relating to field of study, overall and stratified by gender and study semester.

Field of study	*N* (%)	Male *N* (%)	Female *N* (%)	Diverse *N* (%)	First year *N* (%)	Higher year *N* (%)
Natural sciences, mathematics and informatics	712 (18.0)	306 (43.0)	403 (56.6)	3 (0.4)	117 (16.9)	575 (83.1)
Social sciences, media and sport	720 (18.2)	156 (21.7)	560 (77.8)	4 (0.6)	99 (14.3)	594 (85.7)
Language, humanities and cultural studies	795 (20.1)	143 (18.0)	632 (79.5)	20 (2.5)	115 (14.7)	665 (85.3)
Medicine	527 (13.3)	143 (27.1)	384 (72.9)	0 (0.0)	76 (14.6)	445 (85.4)
Economics and law	508 (12.8)	155 (30.5)	352 (69.3)	1 (0.2)	119 (24.2)	373 (75.8)
Education	612 (15.5)	160 (26.1)	450 (73.5)	2 (0.3)	98 (16.5)	497 (83.5)

TABLE 3 | Means, standard deviations, and analysis of variance in PA.

	PA (MET-minutes/week)			insufficiently active	moderately active	Highly active
	N	**Mean**	**SD**	***N* (%)**	***N* (%)**	***N* (%)**
Total	3,961	3,798	2,859	889 (22.4)	696 (17.6)	2,376 (60.0)
Gender						
Female	2,830	3,636	2,792	685 (24.2)	546 (19.3)	1,599 (56.5)
Male	1,100	4,237	2,993	194 (17.6)	145 (13.2)	761 (69.2)
Diverse	31	3,068	2,401	10 (32.3)	5 (16.1)	16 (51.6)
	F (df)	***p***	η_p^2			
Between-subject factor	17.79 (2, 80.46)	<0.001	0.009			
Age						
≤23 years	2224	3770	2841	505 (22.7)	387 (17.4)	1332 (59.9)
>23 years	1734	3836	2883	384 (22.1)	309 (17.8)	1041 (60.0)
	F (df)	***p***	η_p^2			
Between-subject factor	0.51 (1, 3,957)	>0.05	0.000			
Targeted degree						
Bachelor	2,074	3,769	2,939	505 (24.3)	385 (18.6)	1,184 (57.1)
Master	842	3,820	2,928	181 (21.5)	146 (17.3)	515 (61.2)
State examination	869	3,908	2,610	161 (18.5)	130 (15.0)	578 (66.5)
Ph.D.	138	3,518	2,578	30 (21.7)	28 (20.3)	80 (58.0)
	F (df)	***p***	η_p^2			
Between-subject factor	1.13 (3, 609.91)	>0.05	0.001			
Field of study						
Natural sciences, mathematics and informatics	712	3,428	2,673	202 (28.4)	114 (16.0)	396 (55.6)
Social sciences, media and sports	720	3,844	2,820	134 (18.6)	145 (20.1)	441 (61.3)
Language, humanities and cultural studies	795	3,553	2,842	222 (27.9)	154 (19.4)	419 (52.7)
Medicine	527	3,981	2,574	83 (15.7)	84 (15.9)	360 (68.3)
Economics and law	508	3,801	2,726	104 (20.5)	79 (15.6)	325 (64.0)
Education	612	4,312	3,278	127 (20.8)	104 (17.0)	381 (62.3)
	F (df)	***p***	η_p^2			
Between-subject factor	7.41 (5, 1738.09)	<0.001	0.01			
Study semester						
First year students	639	3,574	2,712	150 (23.5)	120 (18.8)	369 (57.7)
Higher year students	3,218	3,853	2,888	708 (22.0)	557 (17.3)	1953 (60.7)
	F (df)	***p***	η_p^2			
Between-subject factor	5.53 (1, 948.12)	<0.05	0.001			

Differences in gender, age, targeted degree, field of study and study semester. Prevalence of insufficiently, moderately and highly active students stratified by gender, age, targeted degree, field of study and study semester.

With regard to field of study, differences in the self-reported time spent sitting differed significantly with negligible effect size ($F_{(5,3816)} = 5.69$, $p < 0.001$, ηp2 = 0.007). *Post-hoc* analysis revealed that students of "social sciences, media and sports" differed statistically significant from those of "natural sciences, mathematic and informatics" ($p < 0.001$) and from those of "economics and law' ($p < 0.05$). Additionally, a statistically significant difference was found between students of "natural sciences, mathematic and informatics" and those of "education" ($p < 0.001$). The highest average sitting time of 7 h 47 min was reported by students of "natural sciences, mathematic and informatics," which are also showing the highest prevalence (52.9 %) of sitting at least 8 h per day. Students of "social sciences, media and sports" stated the lowest average sitting time of 7 h 8 min and lowest prevalence rates of sitting at least 8 h per day (41.2 %) compared to students of other fields of study.

DISCUSSION

In the context of a university-based health promotion program, we investigated PA and SB of students enrolled in the University of Mainz. About 22.4 % of all students that participated in this study did not reach the WHO recommendations for physical activity. In addition, 47.6 % of students sat for 8 h or more a day. This magnitude of physical inactivity and SB negatively affects health and contributes to the development of diseases (18). We found significant differences between female and male students

TABLE 4 | Means, standard deviations, and analysis of variance in SB.

	Sitting time (minutes/day)			Sitting time < 8 h	Sitting time ≥ 8h
	N	**Mean**	**SD**	***N* (%)**	***N* (%)**
Total	3,906	445	164	2,047 (52.4)	1,859 (47.6)
Gender					
Female	2,783	446	161	1,443 (51.9)	1,340 (48.1)
Male	1,094	442	173	593 (54.2)	501 (45.8)
Diverse	29	466	153	11 (37.9)	18 (62.1)
	F (df)	***p***	η_p^2		
Between-subject factor	0.48 (2, 74.80)	>0.05	0.000		
Age					
≤23 years	2,193	442	162	1,187 (54.1)	1,006 (45.9)
>23 years	1,709	449	167	857 (50.1)	852 (49.9)
	F (df)	***p***	η_p^2		
Between-subject factor	2.10 (1, 3608.01)	>0.05	0.001		
Targeted degree					
Bachelor	2,034	438	167	1,124 (55.3)	910 (44.7)
Master	832	447	162	420 (50.5)	412 (49.5)
State examination	866	454	160	423 (48.8)	443 (51.2)
Ph.D.	137	476	159	62 (45.3)	75 (54.7)
	F (df)	***p***	η_p^2		
Between-subject factor	3.94 (3, 3,868)	<0.01	0.003		
Field of study					
Natural sciences, mathematics and informatics	707	467	166	333 (47.1)	374 (52.9)
Social sciences, media and sports	713	427	163	419 (58.8)	294 (41.2)
Language, humanities and cultural studies	773	450	167	410 (53.0)	363 (47.0)
Medicine	524	442	159	268 (51.1)	256 (48.9)
Economics and law	507	455	157	243 (47.9)	264 (52.1)
Education	593	430	166	324 (54.6)	269 (45.4)
	F (df)	***p***	η_p^2		
Between-subject factor	5.69 (5, 3,816)	<0.001	0.007		
Study semester					
First year students	636	441	166	343 (53.9)	293 (46.1)
Higher year students	3,167	446	163	1,655 (52.3)	1,512 (47.7)
	F (df)	***p***	η_p^2		
Between-subject factor	0.49 (1, 3,802)	>0.05	0.000		

Differences in gender, age, targeted degree, field of study and study semester. Prevalence of sitting time (<8 vs. ≥8 h) stratified by gender, age, targeted degree, field of study and study semester.

regarding PA but not regarding SB. Furthermore, we revealed significant differences between the fields of study for both PA and SB. Especially students in the field of "natural sciences, mathematic and informatics" showed increased amounts of physical inactivity and high levels of SB. In comparison, the students in the fields of "medicine" and "education" showed high activity rates. The field of "social sciences, media and sports" was related to lower SB. Students targeting a Ph.D reported significant higher sitting times compared to those targeting a bachelor. There were no significant group-differences for students age and the study semester.

Physical Activity

Recent studies of PA-engagement of adults in Germany revealed a prevalence of at least 47.2 %, who do not meet the PA recommendations (45, 52), which is higher, than the average high-income Western countries (36.8 %) and the global average (27.5 %) (29). The higher rates of university students fulfilling PA recommendations was expected due to the typically younger age of students of 23.8 ± 4.3 years compared to the general population (45, 52). Previous research on 18 to 29 year old persons in Germany found a proportion of 43 % not meeting common PA recommendations (45, 52) indicating that university

students are not only an active population (53), but more active than the age-matched peers in the normal population. International studies on self-reported PA in university students show inconsistent results with inactivity rates ranging from 22 to 79.8 % (22–25, 54–57). Recent investigations on PA in German university students estimated, that approximately 43.6 to 53.9 % of the participants (50, 54) do not meet the PA recommendations, and show, thus, a lower prevalence than this study. However, the surveyed data are difficult to compare to the present study due to different measuring instruments. Altogether, the results of inactivity rates in university students of the present study align directly with previous research when comparable measurement tools were used.

To further increase physical activity in German university students, barriers and motivators of physical activity should be considered when implementing health interventions. The reasons for and against physical activity among university students are very diverse (55). Lack of time, bad weather, and discomfort were highlighted as barriers, whereas health consciousness, weight loss, and stress management were mentioned as motivators (55). Risk groups might help to specify the barriers and incitements of university students.

In this context, our results showed men being significantly more active than women, which aligns with previous studies of the global (56), European (53), and German adult population (52, 57), as well as with current results from university students (31, 58–60). Nelson et al. (23) found, however, a greater extent in over-reporting of PA in men than in women, with no measurable difference between male and female university students using objective measurements. Downs et al. (59) could also show the greater extent of over-reporting PA compared to objective measurements in male students. These authors, however, objectively proved male students to be significant more physically active (45.5 % were at least moderately active) than female students (22.9 % were at least moderately active) (59). Wilson et al. (61) found an emerging discomfort in women regarding the use of recreational facilities, which could be a reason for lower engagement in physical activities. Hereby, perceived lack of skill and self-consciousness, as well as the presence of men seem to play a decisive role (61). Additionally men reported significantly higher activity rates than students assigning themselves as diverse. To date, there are no valid information on the distribution of people assigning themselves as diverse (non-binary). A percentage of 1.7 to 2.1 % of a population is assumed as diverse (62, 63). In the present study, 0.8 % ($n =$ 31) assigned themselves as non-binary, which is lower than the estimated distribution, but in line with previous student health surveys in Germany (31, 50). A total of 32.3 % of the diverse students did not meet PA-recommendations. Current research in the field of physical activity and exercise does not take diverse students into account, even if the relevant data had been collected (31, 50, 60).

Several Eurobarometer Studies (53, 64) found a significant decrease of the engagement in PA from 15–24 to 25–34 year olds. In contrast to that, the results of this study cannot confirm a difference in PA between younger students ($\leq$23 years) and older students ($>$23 years). The inconsistency in the study results could be due to the different categorization and a different age range across all students in the different studies.

To our knowledge, no previous research investigated the effect of the targeted degree on the amount of PA in university students. Although no significant difference was found, the proportion of being insufficiently active among university students targeting a Bachelor's degree (24.3 %) was higher, than the students targeting another degree (18.5–21.7 %). This may be due to the fact that the Bachelor's programme is mainly attended by people who have just started their studies or are in a low study semester. Thus, we found significant differences between first year students and those of higher years. Previous studies are in line with our results of first year students being significantly less active than those of higher years (31, 32). It has been shown, that the transition from secondary school to university is characterized by changes in lifestyle, often leading to an increased risk behavior (1).

The present results show a significant difference between fields of study and are, thus, in contrast to previous study results (31, 50, 54, 65–67). Knowledge seems to exist regarding students in the field of "medicine," that have been reported to be more active than age-matched peers in the general population (68). Previous research is disunited in regard of PA, when compared to non-medical students (31, 67). Results of this study show medical students to be among the highly active sub-population of university students with only 15.7 % being classified as inactive. Likewise, positively accentuated seem to be students of the field of "social sciences, media and sport" as well as "education" and "economics and law." This stands in contrast to the findings of Grützmacher et al. (31), according to which students in the field of social sciences and education were less physically active compared to other fields of study. A possible explanation for the different results compared to other studies could be an inconsistent categorization of the fields of study. The present survey tried to establish a possible universally applicable division of the fields of study based on the pre-work of Dietz et al. (49) and Grützmacher et al. (31).

Sedentary Behavior

In regard of SB, the overall self-reported sitting time in the present study was 445 min (7.42 h). This is 8 min higher (7.29 h) than the average university student, as a recent meta-analysis on SB of university students stated (30). Thereby, Castro et al. (30) reviewed studies being conducted globally, with 32 % carried out at European universities. The average adult ($>$18 years) in Europe, as well as in Germany, usually sits for 5 h per day (69, 70). Age peers in Europe were also sitting for 5 h (18–24 years old), or 4 h per day (25–34 years old), respectively (70). The peers in Germany (18–29 years old) were sitting on average 6.17 h per day (69). Therefore, the presented data demonstrate, that students of the university of Mainz usually sit longer compared to age- and regional peers and compared to previous studies on university students (30). The high amount of sedentary behavior in university students is attributed to the typical activities associated with studying (26–28, 30). These are comparable to those of desk workers sitting on average 7 h per day (70). A threshold of 6 to 8 h of self-reported sitting time per day (14, 47), or 9.5 h of accelerometer derived sitting time per day,

respectively (71), has shown to negatively affect health. Based on the results of the present study, 47.6 % of students were sitting at least 8 h per day and are, thus, exposed to an increased risk for chronic diseases. Similar to research findings in the field of PA, objectively collected data on total sitting time have shown to be even higher than self-reported data (23, 72, 73). In particular, objectively measured sitting time among university students is on average 2 h 14 min higher compared to self-reports (23), which is supported by similar results in the general population underestimating SB by 2.2 to 4 h per day (72, 73).

Prior research reported significant gender differences in sitting time of German adults in favor of men (69). However, there were no gender differences found in the age group of 18 to 29 year olds (69) and in university students (30), which aligns with the results of the present study. To date no valid information on SB regarding non-binary people exists. It might be that the factors explaining variation in university students are different from those in the general population. In addition, SB might be mostly determined by the university setting, which applies equally to all genders.

Castro et al. (30) highlights the lack of knowledge regarding the role of study related risk-factors like the field of study and the targeted degree on SB in university students. The present study found statistically significant differences in the reported sitting time in relation to the targeted degree. Hereby nearly 55% of Ph.D. students reported sitting times of at least 8 h per day with an average sitting time of 7 h 56 min per day, whereas bachelor students reported the lowest average sitting time and highest prevalence of sitting at least 8 h per day. Regarding the targeted degree, SB seems to increase with increasing academic skill level.

We found significant differences in sitting time between the fields of study. Lower sitting times were found in students in the fields of "social sciences, media and sport" still reporting 7 h 7 min of daily sitting time. With a prevalence of 52.9 %, students in the fields of "natural sciences, mathematic and informatics" sit at least 8 h per day. This highlights this sub-group of being at increased risk for negative health effects due to the high amounts of SB.

The study semester had no effect on increasing or decreasing daily sitting time. This is in contrast to current research expecting higher workload with increasing semester and, thus, accumulating more sitting hours in higher year students (30). On the other hand, a reason for higher sitting times in first year students could be longer studying phases due to the lack of individual learning strategies compared to higher year students who may have already developed suitable learning strategies.

Associations of Physical Activity and Sedentary Behavior

Physical inactivity and sedentary behavior are independent risk factors for all-cause mortality, cardiovascular disease mortality and non-communicable diseases (NCD) among others (46). Nevertheless, Castro et al. (74) reported a negative association between physical inactivity and SB in university students (74). A small to medium negative association between MVPA and SB and medium to large association between light-intensity PA and SB was also found in adults (75). Regarding our results, it needs to be highlighted, that students of "natural sciences, mathematic and informatics" are significantly less active and significantly more sedentary. Hereby, especially in the field of "language, humanities and cultural studies" the proportion of female students is higher than the average. Female students have shown to be less active and more sedentary than male students.

Limitations and Future Research

First of all, a possible selection bias of health interested students should be acknowledged and might, therefore, have positively influenced the outcomes for PA and SB (45). Due to the overall length of the questionnaire, it was not possible to differ between weekdays and weekend-days or assess domain-specific distinction concerning PA and SB. Some students may pay attention to a healthy lifestyle, especially on weekends, when they do not have to attend to lectures and seminars. This should be considered in future studies. In addition, the reported outcomes are based on self-reports of PA and SB and could be biased by false information due to social desirability (69). Although the IPAQ-SF is a reliable and valid self-report measurement to assess PA (38, 39, 76) and is recommended to assess the PA level of university students (40, 41), scientific investigations comparing self-reported and objectively measured PA in undergraduate students suggest an over-reporting of PA when using self-report measurements (23, 59). This strengthens the demand for further objective-obtained data in university students.

Moreover, female students account for 59 % of the university population and were overrepresented in the present study (71.4 %). Due to the small sample size of diverse students, further investigations are needed to give more insight in the PA and SB of this population. Furthermore, more research is needed to clarify the impact of the fields of study on health risk behavior in university students. Students' knowledge on health-promoting behavior seems to play an important role for a healthy lifestyle (medicine students vs. other study groups). Future studies should investigate to what extent this knowledge differs among different study subjects and in which field of study further information on health behavior should be communicated. These studies could also examine more detailed, how the program of individual fields of study is structured, how many compulsory courses there are, how many exams there are, how much time needs to be spent studying. In this course it seems important to investigate to what extent learning phases before exams affect the amount of PA and SB in university students. Furthermore, it could be investigated which sporting activities are offered at the university and in the city of Mainz, how the numbers of participants and age as well as gender distributions are. This information might help to subsequently recommend suitable sports or sports groups to the corresponding risk groups or to create more suitable offers.

Due to the small effect sizes, further investigations are necessary to verify our results and confirm the risk groups we have identified.

Practical Relevance–Promoting a Healthy Lifestyle

The results from the present investigation are valuable as they help to identify segments of the student population which may be at greater risk for engaging in less PA and higher volumes of SB. In turn, this information can identify target audiences for policies and interventions on reducing SB and promoting PA in university settings. Although interventions to implement and evaluate a healthy lifestyle seem to be effective in tertiary institutions (77), to date interventions on improving PA and reducing SB in university students remain rare. In this regard, especially individual compared to group interventions showed good effects on health risk (35). However, according to the setting approach, interventions should include larger groups with risky health behavior.

On that account, strategies on reducing SB and promoting physical activity are complementary approaches with individual focus and implementations, representing a dual strategy (30, 78). The significant lower self-reported PA of female students and of non-binary students of the present survey highlight the demand for further gender-sensitive investigations in the field of health behavior as well as interventions adapted to the needs of these groups. Moreover, educational advertising and specific interventions are worthwhile to already take place at the beginning of studies. In addition, a special focus should be placed on the specific characteristics of the fields of study, like "natural sciences, mathematic and informatics" and regarding the targeted degree Ph.D. when applying for health promotion.

Maselli et al. (1) conclude, that effective interventions to promote PA in university students should focus on behavioral determinants. Among others, interventions using internet-based, stage-matched messages (79), Tai Chi (80) and social cognitive PA interventions (81) were found to benefit health in university students. Regarding SB, breaking up prolonged sitting with frequent bouts of standing or light-intensity PA have shown to improve stroke risk factors (82). Interventions aiming to reduce negative effects due to SB should therefore, not exclusively focus on reducing overall time being sedentary, but also breaking up prolonged sitting with bouts of light-intensity PA or standing (83). Future investigations should focus on the effectiveness of interventions targeting specific risk groups of health among the student population.

CONCLUSION

In summary, our study results showed a high level of PA combined with high amounts of SB in university students. Consequently, this population requires specific interventions that particularly counteract high sitting time. To identify subgroups of increased risk for a poor lifestyle, we examined sociodemographic and study-related differences in PA and SB behaviors. Female students, students from the field of "natural sciences, mathematic and informatics," Ph.D.-students and first year students, seem to be subgroups at increased risk. Based on these findings, prevention and intervention models need to be established in university health-promotion programmes, in which the facilitation of PA and the reduction of SB in these specific subgroups should be key parts. Despite the findings in the present study, future research should evaluate a combination of objective accelerometer-derived and self-reported information as is recommended to assess PA and SB. Further, prospective research should be performed to identify possible barriers to physical activity and possible reasons for high amounts of SB in sub-populations of university students to initiate and implement suitable prevention and intervention programmes.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Committee of the Medical Association of Rhineland-Palatinate. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

Conception and design: DE, DP, PD, JR, AW, AT, MS, ND, SL, and PS. Acquisition of data: DE, DP, PD, JR, AW, AT, MS, ND, and SL. Analysis and interpretation of the data: DE, DP, SH, PS, and KK. Drafting of the article: DE, DP, and KK. Critical revision of the article for important intellectual content and final approval of the article: All authors.

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