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Mental burden and perception of the study situation among undergraduate students during the COVID-19 pandemic: a cross-sectional study and comparison of dental and medical students

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ABSTRACT

Objectives: To investigate levels of distress, depression, anxiety, stress and perception of their current study situation during the COVID-19 pandemic among undergraduate dental and medical students.

Design: Observational, cross-sectional study including two consecutive surveys (May and July 2020).

Setting: A large medical school in Germany.

Participants: All first year dental and medical students were invited. 132 participating first year students (44 dental, 88 medical) from the first survey and 150 students (50 dental, 100 medical) from the second were included in our analyses.

Primary and secondary outcome measures: Mental burden (Distress Thermometer, Patient Health Questionnaire PHQ-4, Perceived Stress Scale, PSS-4) and self-reported changes in mental health and perception of study situation during the COVID-19 pandemic (self-developed items) were compared. Open-ended questions were analyzed by conventional content analyses.

Results: A considerable proportion of students (May 2020: 84%; July 2020: 77%) reported distress levels above cutoff. In July 2020, dental students reported significantly higher distress scores than medical students. More dental than medical students reported mild, moderate and severe levels of anxiety and depression symptoms. The majority stated that their mental health and study motivation had not changed during the pandemic. Logistic regression showed that being a dental student and experiencing higher distress were significantly associated with a higher likelihood for serious worries. Regarding current concerns related to the pandemic, students most frequently reported difficulties with self-regulated learning (15%), study-related worries and uncertainty (14%), missing feedback of students and lecturers (11%) and lack of practical training (10%).

Conclusion: The results suggest that high mental burden and the lack of practical training among medical and dental students is an increasing problem, with a possibly even higher urgency in dental students. Tailored psychological and educational support offers during and after the COVID-19 pandemic might help them as they progress through (medical and) dental school.

Strengths and limitations of this study

- This study offers in-depth exploration of students' mental health and perception of their study situation during the COVID-19 pandemic by combining quantitative data and qualitative data
- This study included well-established and valid instruments (quantitative data) and applied conventional content analyses with inductive categorization (qualitative data).
- Response rates of this study were high (65% - 87%).

- It is a single-institution study and the cross-sectional design does not allow causal statements about longitudinal developments.

INTRODUCTION

The corona virus disease (COVID-19) pandemic and its consequences have an impact on the private, professional and social life of all people[1]. It has brought widespread disruption to undergraduate medical education[2, 3]. Thus medical students worldwide face major changes regarding their medical training and study motivation decreased[4]. Many medical schools have made changes to their curricula and campus life to protect patients and students by social distancing. Roles of medical students' during the COVID-19 pandemic are discussed controversial[5]. Even in the absence of the COVID-19 pandemic, mental burden is common among medical students[6, 7, 8] and several studies report lower mental health outcomes for medical students in the course of their medical studies compared to population reference samples[9]. In particular, depression and anxiety symptoms are reported among medical[7, 10] and dental students[11-13]. Often students feel that they do not have adequate coping strategies to deal with study-related workload and stress[14]. Dental students are highly stressed and perform at a comparable or higher stress level than medical students[15]. Studies have shown that the stress level increases with each semester, especially due to the high proportion of practical training in dental studies[13, 16].

In light of novel circumstances during the COVID-19 pandemic, uncertainty relating to personal and professional future and rapid changes medical students may be even more at risk of experiencing severe mental burden during the pandemic than before. Increased incidence rates of stress and mental burden are an expected response under the current conditions[17].

Studies have shown the negative impact of past pandemics[18] and the COVID-19 pandemic[19] on the general population, as well as on specific groups[20]. Health professionals may be particularly affected[21], as pandemic-specific stressors are added to the general ones[22]. High prevalence for mental health symptoms among health care workers exposed to COVID-19 was found[20]. Students are also highly burdened while facing new challenges raised by the pandemic's consequences[23, 24]. COVID-19 related mental stress, higher rates of depression and a high symptom burden from the acute stress response according to the COVID-19 pandemic are common especially among health care students[25], as they have to cope with mental and emotional issues, including stress and anxiety.

In contrast to the exposure of students in general during the COVID-19 pandemic, the mental burden of medical and dental students in particular is still poorly addressed in the international literature even though they are facing special challenges in health care[26].

Therefore, the aim of this study was to assess the magnitude of distress, depression and anxiety and stress among undergraduate dental and medical students in the course of the COVID-19 pandemic. Secondly, we aimed to explore students' perception of the study situation during the pandemic and compare dental and medical students' perception during the first lockdown period and thereafter.

METHODS

Design and setting

This observational study consists of two cross-sectional surveys conducted at the University Medical Center Hamburg-Eppendorf, Germany, from May 28, 2020 to June 7 (t1), 2020 and from July 16, 2020 to July 31, 2020 (t2). During this period and before (since mid-March 2020) the German government announced several public health measures to suppress the spread of COVID-19 by increasing social distancing, i.e. the closure of schools, daycare, playgrounds and non-essential shops, the prohibition to meet more than one person from another household and depending on regional regulations the prohibition to leave the apartment without reason[27]. Concurrently lectures and seminars at the universities were predominantly held in a digital format to reduce interpersonal contact and to protect patients, students and faculty[28]. Thus, the learning environment and examination conditions for students have changed significantly. Many medical schools have discontinued their undergraduate medical training and transitioned most of their teaching to digital formats[29]. This included but was not limited to the transformation of Objective Structured Clinical Examinations (OSCE[30]) into Multiple Choice tests.

Participants

All first year dental students (n=68) enrolled in the integrated dental degree program iMED DENT launched in 2019 and medical students (n=352) enrolled in the integrated medical degree program iMED established in 2012 at the Medical School of the University of Hamburg, Germany[31] were invited to participate in the online surveys. Students were asked to complete an anonymous questionnaire linked to the voluntary curriculum evaluation conducted by the dean's office in regular intervals during the course of the year. A few days in advance the students were informed via e-mail of the study aims, voluntary participation and data protection regulations.

Measures

We developed an online questionnaire and focused on symptoms of distress, depression and anxiety and stress by using established self-reporting questionnaires. Furthermore, we assessed the perception of the study situation during the pandemic and study motivation with self-developed items. Demographic characteristics (age in categories, gender) were also self-reported.

Distress

We assessed students' distress at t1 (May 2020) and t2 (July 2020) using the German version of the Distress-Thermometer (DT), a brief screening instrument developed by the National Comprehensive Cancer Network (NCCN)[32]. The DT is a single-item instrument with a scale from 0-10. Higher scores indicate higher distress. Internationally a cutoff score of 4 is established as a signal that a person is distressed and needs support. The DT is a reliable and efficient screening instrument[32].

Depression and anxiety

We measured depression and anxiety using the German version of the four-item Patient Health Questionnaire (PHQ-4), an ultra-brief screening instrument that consists of a two-item depression scale (PHQ-2) and a two-item anxiety scale (GAD-2)[33]. It assesses the amount of depression and anxiety symptoms the individual has felt during the past two weeks. A score of 3 or higher on the PHQ-2 and GAD-2 is established as a reasonable cut-off score clinically relevant levels of depressive and anxiety symptoms. The total PHQ-4 score is considered as an overall measure of symptom burden with the following categories: 0-2 normal, 3-5 mild, 6-8 moderate, 9-12 severe. It is an efficient screening instrument with good internal consistency and construct validity and areas under the curve between 0.84 (anxiety) and 0.79 (depression) among students[34].

Changes in mental health and perception of study situation during the COVID-19 pandemic

Furthermore we administered five self-developed items to assess changes in students' mental health and perception of the study situation: Students were asked whether their mental health has changed since the beginning of the pandemic with five answer options (clearly improved; rather improved; unchanged; rather worsened; clearly worsened). They were asked if the assessment of their study situation has changed in the context of the pandemic with three answer options (No, I am as worried or unworried as before; Yes, I am somewhat worried; Yes, I am seriously worried). Furthermore students were asked if the pandemic affected their possibility to participate in exams with five options to answer (No exams took place since the beginning of the pandemic; Exams took place without changes; Exams did not take place, but a new date is scheduled; Exams did not take place and no new

date is scheduled yet; I was not able to attend exams due to quarantine or illness). Students were asked if their study motivation had changed since the beginning of the pandemic. Answers were rated on a 5-point Likert-type scale (clearly increased; rather increased; unchanged; rather decreased; clearly decreased). Finally, students were asked for free text responses regarding the question what currently is occupying them most in their current study situation and what they experience as particularly helpful.

Stress

In the second survey students' perception of stress was quantified with the Perceived Stress Scale (PSS-4). The 4-item self-report instrument with reverse coding for two items assesses on a five-point Likert scale the degree to which situations in one's life were perceived as stressful in the past month[35]. Higher scores on the PSS-4 indicate higher stress levels.

Burdening aspects

For the second data collection in July 2020, we developed six items based on the qualitative results from the first survey to assess burdening aspects experienced by the students' quantitatively. The respondents had the possibility to answer in four levels (1 = "not at all burdensome" to 4 = "very burdensome").

Data analysis

We matched dental students to medical students according to age and gender in the ratio of 1:2 in order to harmonize the initially inhomogeneous sample sizes and enhance comparability of the samples. In May 2020, the final sample consisted of n=132 students (44 dental and 88 medical students). In July 2020, the sample comprised 150 students (50 dental and 100 medical students). With 74% (t1) and 69% (t2) female students the gender ratio of the sample is comparable to the ratio of first year students at German medical schools[36]. We used descriptive statistics to characterize the sample. Group comparisons were carried out using chi^2-tests for categorical variables and t-tests for differences of means.

We conducted descriptive analyses to examine the magnitude of distress (DT), depression and anxiety (PHQ-4), and stress (PSS-4). The results of the entire sample as well as of the subgroups (dental and medical students) were compared with PHQ-4 data of a German medical student sample (n=321, mean age=22 years, 60% women) from a previous study at the same faculty[8] with one-sample t-tests. To

examine the likelihood for serious worries (dichotomous) regarding the study situation during the COVID-19 pandemic at t1 we conducted a binary logistic regression model with sex, subject of study, the magnitude of distress, depression and anxiety as potential predictors. Non-significant variables were excluded via backward elimination and dropped at the level of $p < 0.05$. We applied likelihood ratio method, which is recommended for stepwise methods[37]. To avoid multicollinearity, we analyzed Variable Inflation Factors (VIF) scores. We conducted effect size calculations and considered according to Cohen's $f^2 = .02$ to be a small effect, $f^2 = .15$ as a medium effect, and $f^2 = .35$ as a large effect[38]. All quantitative analyses were carried out using IBM SPSS version 27.

We used conventional content analyses with inductive categorization to analyze the free text responses[39]. Two researchers familiarized themselves with the qualitative data (IH, JG). They identified key concepts and generated labels of codes for recurring themes independently. Next, both sorted codes into categories independently, which were reviewed by all authors. We developed final definitions for categories and codes with iterative consultations and discussions until consensus was achieved. We chose excerpts to exemplify each category and translated them into English. For the qualitative data analysis, we used MAXQDA 2020 (VERBI Software, 2019).

Following the inductive categorization we recoded answers for each category into dichotomous variables (mentioned vs. not mentioned) to enhance data transparency and to provide evidence for our interpretation[40]. When students provided more than one category per response, all responses respectively categories were categorized. The qualitative results of the first survey served as the basis for developing six quantitative items for the second survey.

The local ethics board of the Center for Psychosocial Medicine at the University Medical Center Hamburg-Eppendorf approved the study (LPEK-0161).

Patient and Public Involvement

We did not involve patients in our study. Research questions were developed by the principle investigators (CB, JG) and discussed with the Curriculumkommitee iMED, Hamburg (CK iMED) in April 2020. CK IMED is a committee consisting of students, teachers and a member of the dean's office, which has the task of further developing and optimizing the structure and content of the reformed medical degree program iMED. Subsequently all enrolled students were informed by e-mail about the design, conduct, the outcome measures and the recruitment and encouraged to give feedback. After publication a summary of the results will be presented in plain language on the website of the University Medical Center Hamburg-Eppendorf.

RESULTS

Of 68 first year dental students enrolled in the dental education program at the UKE in May 2020, 44 (65%) completed the first survey (t1) in May 2020 and were matched to 88 medical first year students who completed the t1 survey as described above (overall response rate of the medical students was 87%). The response rate of the second survey (t2) was 81% among first year dental students and 82% among first year medical students. With 75% (t1) and 70% (t2) female dental students and 40% (t1 and t2) aged 20 years and younger, both samples are similar to the population of first year dental students at the faculty. The demographic characteristics of the final samples are shown in Table1.

Table 1: Sample characteristics among dental and medical students participating in the first (n^1=132) and second survey (n^2=150)

		First Survey (May 2020)			Second Survey (July 2020)	
	Whole sample (n=132)	**Dental students** (n_1=44)	**Medical students** (n_1=88)	**Whole sample** (n=150)	**Dental students** (n_2=50)	**Medical students** (n_2=100)
	%	%	%	%	%	%
sex:						
male	28.8	25.0	26.1	30.7	30.0	31.0
female	74.2	75.0	73.9	69.3	70.0	69.0
age:						
Up to 20 years	38.6	39.7	38.6	40.0	40.0	40.0
21-25 years	34.1	33.8	34.1	34.0	34.0	34.0
26-30 years	18.2	17.6	18.2	18.0	18.0	18.0
31-35 years	6.8	5.9	6.8	6.0	6.0	6.0
Older than 35 years	(2.5	2.9	2.3	2.0	2.0	2.0

Distress, depression and anxiety

Overall, high levels of distress, anxiety and depression were found in both dental and medical students. Compared to a German reference sample [41] with an overall mean PHQ-4 score of 1.76 (SD=2.02) and of 1.48 (2.00) for a student subsample, our samples reported on average significantly higher anxiety and depression (PHQ-4) scores at t1 and t2: In May 2020 80% of the dental students and 86% of the medical students reported moderate or severe distress scores and 25% of the dental students and 24% of the medical students reported moderate to severe anxiety and depression scores. In July 2020 dental students reported significantly higher levels of distress and anxiety than medical students (Table 2). With regard to gender differences, the scores of male and female students did overall not differ significantly in the whole sample at t1 and t2. However, female dental students (t1: M=4.67; SD=2.58; t2: M=4.6; SD=2.76) reported significantly higher PHQ-4 scores than male dental students (t1: M=2.82; SD= 1.54; t2: M=2.87; SD= 2.56) at t1 ($t(42)= -2.235$, p=.031) and t2 ($t(48)= -2.080$, p= .043).

In July 2020 (t2), dental students reported significantly higher scores of distress and anxiety than medical students, while both groups were comparable with regard to their overall anxiety and depression symptom burden (24% with moderate or severe symptoms in dental students, 19% in medical students). With regard to self-perceived stress (only assessed in the second survey), dental students reported higher stress levels than medical students (Table 2).

Table 2: Amount of self-reported distress, depression and anxiety and stress among dental and medical students in May 2020 (n^1=132) and July 2020 (n^2=150)

	May 2020						July 2020					
	Whole sample	Dental students (n=44)	Medical students (n=88)				Whole sample	Dental students (n=50)	Medical students (n=100)			
	M (SD)	M (SD)	M (SD)	t	df	p	M (SD)	M (SD)	M (SD)	t	df	p
Distress (range: 0-10)	6.41 (2.38)	6.32 (2.45)	6.45 (2.35)	.310	130	.757	6.14 (2.22)	7.02 (2.25)	5.70 (2.07)	-3.571	148	**<.001**
Anxiety and depression (PHQ-4; range 0-12)	3.95 (2.49)	4.20 (2.48)	3.83 (2.50)	0.815	130	.417	3.73 (2.67)	4.08 (2.79)	3.56 (2.60)	1.126	148	.262
Anxiety (GAD-2; range 0-6)	1.95 (1.49)	2.09 (1.51)	1.88 (1.48)	0.785	130	.435	1.91 (1.58)	2.28 (1.81)	1.73 (1.43)	2.025	148	**.045**
Depression (PHQ-2; range 0-6)	2.01 (1.31)	2.11 (1.28)	1.95 (1.33)	0.656	130	.513	1.82 (1.35)	1.80 (1.31)	1.83 (1.37)	-.128	148	.898
Self-perceived Stress (PSS-4; range 0-16)	-	-	-	-	-	-	5.60 (3.07)	6.14 (3.22)	5.33 (2.96)	1.533	148	.128
Anxiety and depression symptoms (PHQ4)	%	%	%	chi²	df	p	%	%	%	chi²	df	p
normal (0-2)	31.8	25.0	35.2	1.535	3	.674	38.0	36.0	39.0	0.557	3	.906
mild (3-5)	43.9	50.0	40.9				41.3	40.0	42.0			
moderate (6-8)	19.7	20.5	19.3				13.3	16.0	12.0			
severe (9-12)	4.5	4.5	4.5				7.3	8.0	7.0			
Distress by category	%	%	%	chi²	df	p	%	%	%	chi²	df	p
Normal (0-4)	14.9	20.5	13.6	1.022	2	.600	22.7	16.0	26.0	9.652	2	**.008**
Moderate (5-7)	50.8	47.7	52.3				49.3	40.0	54.0			
Severe (8-10)	33.3	31.8	34.1				28.0	44.0	20.0			
Over cutoff (≥5)	84.1	79.5	86.4	1.019	1	.313	77.3	84.0	74.0	1.902	1	.168

Note. n=number; M = mean; SD = standard deviation; df = degrees of freedom; p = p-value, significance level p<.05

Changes in mental health and perception of the study situation

Overall, about one third of the students (36% dental students vs. 30% medical students) reported that their mental health had worsened because of the pandemic at t1**.** Likewise, a total of 36% (46% dental vs. 31% medical students) reported a decrease in their study motivation at t1 and 37% at t2 (36% dental vs. 37% medical students). With regard to worries about the current study situation more medical students (t1 46%; t2 48%) than dental students (t1 32%; t2 35%) reported to be unperturbed and slightly more dental than medical students were seriously worried at t1 (18% vs. 6%) and at t2 (14% vs. 10%). However, in both surveys dental and medical students did not differ significantly regarding their self-reported changes of mental health, study motivation or worries about the current study situation (Table 3). Likewise, we did not find significant differences between male and female students (data not shown).

Table 3: Perception of current study situation, changes of self-reported mental health caused by the COVID-19 pandemic and changes of study motivation of dental and medical students in May 2020 (n^1=132) and July 2020 (n^2=150)

	May 2020						July 2020					
Worries about current study situation	**Whole sample**	**Dental students (n=44)**	**Medical students (84<n>88)**				**Whole sample**	**Dental students (49<n>50)**	**Medical students (99<n>100)**			
	%	**%**	**%**	**chi²**	**df**	**p**	**%**	**%**	**%**	**chi²**	**df**	**p**
Not worried	40.2	31.8	46.4	5.774	2	.056	42.7	34.7	47.5	2.273	2	.321
Somewhat worried	47.0	50.0	47.6				44.7	51.0	42.4			
Seriously worried	9.8	18.2	6.0				11.3	14.3	10.1			
Self-reported changes of mental health caused by the COVID-19 pandemic												
improved	19.7	22.7	18.2	1.518	2	.468	Not asked.					
unchanged	48.5	40.9	52.3									
worsened	31.8	36.4	29.5									
Self-reported changes of study motivation												
increased	13.6	11.4	14.8	2.794	2	.247	16.0	16.0	16.0	0.016	2	.992
unchanged	50.8	43.2	54.5				47.3	48.0	47.0			
decreased	35.6	45.5	30.7				36.7	36.0	37.0			
Burdening aspects[1]	Not asked						**Whole sample**	**Dental students (49<n>50)**	**Medical students (99<n>100)**	**chi²**	**df**	**p**
Preparation for (final) exams	-	-	-	-	-	-	63.3	76.0	57.0	5.182	1	**.023**
Lack of practical training	-	-	-				43.3	52.0	39.0	2.294	1	.130
Few social contacts (private)	-	-	-				43.3	34.0	48.0	2.661	1	.103
Lack of interaction with fellow students	-	-	-	-	-	-	56.0	52.0	58.0	.487	1	.485
Concomitants of the CoViD-19 pandemic (contact restrictions, mandatory facemasks, etc.)	-	-	-				22.0	24.0	21.0	.175	1	.676
General uncertainty	-	-	-				36.0	54.0	27.0	10.547	1	**.001**

Note: n=number; M = mean; SD = standard deviation; df = degrees of freedom; p = p-value, significance level p<.05

[1]dichotomized: burdened (s. Table above) including “somewhat burdensome” and “very burdensome” vs. not burdened including “not at all burdensome” and “a little burdensome”

Burdening aspects

Many of students felt burdened due to the lack of interaction with fellow students. In comparison to medical students, significantly more dental students stated that they were burdened with regard to the exams and the general uncertainty (Table 3).

Binary logistic regression indicated that medical students were significantly more likely to experience serious worries regarding the current study situation during COVID-19 than dental students at t1. At t2 higher distress was associated with a higher likelihood for reporting serious worries regarding the current study situation during COVID-19 (Table 4).

Table 4: Binary logistic regression models on the association of study subject, depression and distress with serious worries in dental and medical students during the COVID-19 pandemic.

May 2020	**Odds ratio (OR)**	**95% confidence interval (CI)**	***P* value**	***effect size*[1]**
Subject of study				
dental	Reference		n.a.	
medical	1.149	1.013 - 1.304	**.031**	.032
Distress (DT)	1.386	0.965 -1.991	.078	
Depression symptoms (PHQ-2)	1.549	0.933 - 2.571	.091	
July 2020				
Distress (DT)	1.802	1.277 – 2.542	**.001**	0.24

[1]According to Cohen's guidelines (1988) we considered f2= .02 to be a small effect, f2=.15 as a medium effect, and f2=.35 as a large effect.

Current concerns and helpful aspects

A total of 52 students (39%) provided optional free-text responses regarding the question "What is currently occupying you most in your current study situation?". We identified five categories in a multistage inductive process. The most frequent categories were "difficulties with self-regulated learning and self-motivation", followed by "study-related worries and uncertainty", "lack of feedback from other students and lecturers" and "lack of practical training". Significantly more dental (21%) than medical students (5%) reported concerns about the lack of practical training ($chi^2 = 8.362$; df = 1; p = .004; p < .05) (Table 5).

Furthermore, 53 students (40%) completed optional free-text responses to the question "What do you currently experience as particularly helpful?". Again five categories were identified through a multi-step inductive process. The most common categories were "Exchange with other students and lecturers", followed by "flexibility due to online lessons", "self-regulation, -motivation and -

structuring", and "balance through sports and leisure". Dental and medical students did not differ significantly in their answers with regard to helpful aspects (Table 5).

Table 5: Categories, examples and quantified responses by category for the questions “What is currently occupying you most in your current study situation?” and “What do you currently experience as particularly helpful?” in May 2020 (n=132)

What is currently occupying you most?		Whole sample (n=132) mentioned	Dental students (n=44) mentioned	Medical students (n=88) mentioned			
Category and subcategory	**Example**	**%**	**%**	**%**	**Chi²**	**df**	**p**
Difficulties with self-regulated learning (n = 20; 15%) • Self-Motivation • Difficulties with new learning environment	"Self-motivation- the exchange with fellow students and lecturers is missing, and therefore one has to motivate oneself every day anew to sit down at home (the library as a room for studying is also missing) and to motivate oneself to nevertheless 'attend' all study courses in time and to catch up on the study-work." "Since I don't have the proper learning environment at home, I found it difficult to learn the very extensive content in an appropriate manner."	15.2	15.9	14.8	0.029	1	.864
Study-related worries and uncertainty (n = 19; 14%)	"Extreme pressure to teach myself the mass of content in a short time through e-learning in order to succeed on the exam."	14.4	20.5	11.4	1.967	1	.161

• Concerns to perform worse/ to fail • Study-related uncertainty	"The uncertainty of if and when face-to-face classes can be held again, and if potentially my study time will be extended due to this pandemic."						
Lack of feedback from other students and lecturers (n = 15; 11%)	"Due to the online format, the exchange with fellow students and the lecturers is missing. (…)."	11.4	11.4	11.4	0.000	1	1.000
Lack of practical training (n = 13; 10%)	"The practical components in dental education are essential and (...) are now being cancelled. (…)"	9.8	20.5	4.5	8.362	1	**.004**
Other (n = 9; 7%)	"Lack of available childcare. Learning with (...) children at home is a challenge."	6.8	11.4	4.5	2.146	1	.143
What do you currently experience as particularly helpful?							
Category	**Example**						
Exchange with students and lecturers (n = 18; 14%)	"Intensive exchange with fellow students and lecturers."	13.6	15.9	12.5	0.289	1	.591
Flexibility due to online lessons (n = 17; 13%)	"The online semester also brings many advantages. You can arrange everything yourself and work at your	12.9	15.9	11.4	0.540	1	.462

	own pace. This also takes away a lot of stress for me personally (...)"						
Structure and self-discipline (n = 13; 10%)	"Studying online to regain routine in everyday life."	9.8	11.4	9.1	0.171	1	.680
Balance through sports and leisure (n = 11; 8%)	"The fact that I can do my team sports again, that gives me enough variety and distraction "	8.3	11.4	6.8	0.793	1	.373
Other (n = 9; 7%)	"Encouragement of friends and family"	6.8	9.1	5.7	0.537	1	.464

Note: n=number; df = degrees of freedom; p = p-value, significance level p<.05

DISCUSSION

This study investigated the mental burden and study situation among undergraduate dental and medical students after the initial stage of the COVID-19 pandemic from May 2020 to July 2020. In line with previous studies conducted before the pandemic dental and medical students reported high levels of distress, anxiety and depression[8, 12, 42]. Compared to the norm population students of both professions reported significantly higher levels of anxiety and depression, consistent with findings of other studies[8, 43]. In light of the COVID-19 pandemic, the presence of additional pandemic specific stressors is likely[22]. A recent study showed that for most students isolation from student social networks is associated with increased anxiety levels[24]. According to our qualitative data, the lack of direct contact with fellow students, which could only take place via online media, affects both student professions negatively. For dental students, the lack of practical training played a major role, as dentists usually take dental courses from the first semester onwards to learn the practical skills from early stage on[44]. In comparison, this issue does not yet affect medical students as much in the early stages of their studies, as the undergraduate medical curriculum in Germany includes fewer practical training during this time[45]. In sum this probably accounts for our findings that reported levels of anxiety and depression are even higher than among students of the same medical school prior to the Corona pandemic[8].

With regard to the study situation, medical and in particular dental students were concerned about their current study situation. This trend continued in the further course of the pandemic. These results corroborate recent findings in a representative sample in Austria with a notable decline in mental health during the pandemic[46].

In line with the findings of Stangvaltaite-Mouhat et al. (2020) female dental students showed more pronounced anxiety symptoms than male dental students in our study[11]. This underlines that mental burden may be higher among female students in general[47]. Recent studies also suggest that women are particular burdened during the COVID-19 pandemic[46, 48, 49, 50, 51]. Furthermore several studies showed that certain age groups, including individuals between 18 and 25 years old - the most common age group in students - suffered more from mental distress[46, 48, 50, 52]. Qiu et al. (2020) suspect social media to be one of the causes[48]. Previous research seems to confirm this hypothesis as younger people tend to receive a large amount of information via social media, which can easily trigger stress[53]. The easy accessibility and constant presence of pandemic information may lead to an increase in the duration of information consumption. This increasing duration reinforces the potential negative influence on mental health[54]. A noteworthy finding is that dental students reported increased levels of distress, anxiety and more worries in the second survey whereas medical students' scores were slightly lower at the second survey.

There are some limitations of our study. The cross-sectional surveys at two different times do not allow causal statements about longitudinal developments. However, due to the high response rates (65-87% in the first and 81-82% in the second survey) one may assume that a majority of the respondents participated in both surveys. Thus, these single-institutional and cross-sectional surveys achieve a high level of comparability and representativeness.

Furthermore, no comparisons can be made with the situation before the outbreak of the pandemic, among the same population. Nevertheless, the study by Heinen et al. (2017) conducted at the same medical school with the same measures serves as a valid context to frame our findings[8].

Conclusion

Overall students of medicine and dentistry are particularly affected by high mental distress and burden due to the demanding contents and structure of their studies. It is likely that the concomitant symptoms of the pandemic have an additional negative impact on the levels of stress, anxiety and depression of the students.

Especially dental students reported higher levels of burden which might be associated with the high practical content early in their studies. The increase in anxiety levels of dental students might be associated with the duration of the restrictions of especially the practical content during the undergraduate study. Against this background, further monitoring of both dental and medical students during pandemic times and would be important in order to develop and introduce tailored prevention concepts adapted to the specific study situation.

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Based on the STROBE cross sectional guidelines.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1

Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5

Bias	#9	Describe any efforts to address potential sources of bias	7
Study size	#10	Explain how the study size was arrived at	4
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	6
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	6
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	6
Statistical methods	#12c	Explain how missing data were addressed	4
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	n/a
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	7
Participants	#13b	Give reasons for non-participation at each stage	n/a

Participants	#13c	Consider use of a flow diagram	n/a
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	7-8
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	9; 11
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	n/a
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
Main results	#16b	Report category boundaries when continuous variables were categorized	9
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	#18	Summarise key results with reference to study objectives	17

Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	18
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	18
Generalisability	#21	Discuss the generalisability (external validity) of the study results	18
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

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Mental burden and perception of the study situation among undergraduate students during the COVID-19 pandemic: a cross-sectional study and comparison of dental and medical students

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Mental burden and perception of the study situation among undergraduate students during the COVID-19 pandemic: a cross-sectional study and comparison of dental and medical students

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ABSTRACT

Objectives: To investigate levels of distress, depression, anxiety, stress and perception of their current study situation during the COVID-19 pandemic among undergraduate dental and medical students.

Design: Observational, cross-sectional study including two consecutive surveys (May and July 2020).

Setting: A large medical school in Germany.

Participants: All first year dental and medical students were invited. 132 participating first year students (44 dental, 88 medical) from the first survey and 150 students (50 dental, 100 medical) from the second were included in our analyses.

Primary and secondary outcome measures: Mental burden (Distress Thermometer, Patient Health Questionnaire PHQ-4, Perceived Stress Scale, PSS-4) and self-reported changes in mental health and perception of study situation during the COVID-19 pandemic (self-developed items) were compared. Open-ended questions were analyzed by conventional content analyses.

Results: A considerable proportion of students (May 2020: 84.1%; July 2020: 77.3%) reported distress levels above cutoff. In July 2020, dental students reported significantly higher distress scores than medical students (dental: M=7.0, SD=2.3; medical: M=5.7; SD=2.1; p<.001). More dental than medical students reported mild, moderate and severe levels of anxiety and depression symptoms. The majority stated that their mental health and study motivation had not changed during the pandemic. Logistic regression showed that being a dental student and experiencing higher distress were significantly associated with a higher likelihood for serious worries (OR: 4.0; CI (95%): 1.1 – 14.2). Regarding current concerns related to the pandemic, students most frequently reported difficulties with self-regulated learning (15.2%), study-related worries and uncertainty (14.4%), missing feedback of students and lecturers (11.4%) and lack of practical training (9.8%).

Conclusion: The results suggest that high mental burden and the lack of practical training among medical and dental students is an increasing problem, with a possibly even higher urgency in dental students. Tailored psychological and educational support offers during and after the COVID-19 pandemic might help them as they progress through (medical and) dental school.

Strengths and limitations of this study

- This study offers in-depth exploration of students' mental health and perception of their study situation during the COVID-19 pandemic by combining quantitative data and qualitative data
- This study included well-established and valid instruments (quantitative data) and applied conventional content analyses with inductive categorization (qualitative data).

- Response rates of this study were high (65.3% - 87.2%).
- It is a single-institution study and the cross-sectional design does not allow causal statements about longitudinal developments.

INTRODUCTION

The corona virus disease (COVID-19) pandemic and its consequences have an impact on the private, professional and social life of all people[1]. It has brought widespread disruption to undergraduate medical education[2, 3]. Thus medical students worldwide face major changes regarding their medical training and study motivation decreased[4]. Many medical schools have made changes to their curricula and campus life to protect patients and students by social distancing. Roles of medical students' during the COVID-19 pandemic are discussed controversial[5]. Even in the absence of the COVID-19 pandemic, mental burden is common among medical students[6, 7, 8] and several studies report lower mental health outcomes for medical students in the course of their medical studies compared to population reference samples[9]. In particular, depression and anxiety symptoms are reported among medical[7, 10] and dental students[11-13]. Often students feel that they do not have adequate coping strategies to deal with study-related workload and stress[14]. Dental students are highly stressed and perform at a comparable or higher stress level than medical students[15]. Studies have shown that the stress level increases with each semester, especially due to the high proportion of practical training in dental studies[13, 16].

In light of novel circumstances during the COVID-19 pandemic, uncertainty relating to personal and professional future and rapid changes medical students may be even more at risk of experiencing severe mental burden during the pandemic than before. Increased incidence rates of stress and mental burden are an expected response under the current conditions[17].

Studies have shown the negative impact of past pandemics[18] and the COVID-19 pandemic[19] on the general population, as well as on specific groups[20]. Health professionals may be particularly affected[21], as pandemic-specific stressors are added to the general ones[22]. High prevalence for mental health symptoms among health care workers exposed to COVID-19 was found[20]. Students are also highly burdened while facing new challenges raised by the pandemic's consequences[23, 24]. COVID-19 related mental stress, higher rates of depression and a high symptom burden from the acute stress response according to the COVID-19 pandemic are common especially among health care students[25], as they have to cope with mental and emotional issues, including stress and anxiety.

In contrast to the exposure of students in general during the COVID-19 pandemic, the mental burden of medical and dental students in particular is still poorly addressed in the international literature even though they are facing special challenges in health care[26].

Therefore, the aim of this study was to assess the magnitude of distress, depression and anxiety and stress among undergraduate dental and medical students in the course of the COVID-19 pandemic. Secondly, we aimed to explore students' perception of the study situation during the pandemic and compare dental and medical students' perception during the first lockdown period and thereafter.

METHODS

Design and setting

This observational study consists of two cross-sectional surveys conducted at the University Medical Center Hamburg-Eppendorf, Germany, from May 28, 2020 to June 7 (t1), 2020 and from July 16, 2020 to July 31, 2020 (t2). During this period and before (since mid-March 2020) the German government announced several public health measures to suppress the spread of COVID-19 by increasing social distancing, i.e. the closure of schools, daycare, playgrounds and non-essential shops, the prohibition to meet more than one person from another household and depending on regional regulations the prohibition to leave the apartment without reason[27]. Concurrently lectures and seminars at the universities were predominantly held in a digital format to reduce interpersonal contact and to protect patients, students and faculty[28]. Thus, the learning environment and examination conditions for students have changed significantly. Many medical schools have discontinued their undergraduate medical training and transitioned most of their teaching to digital formats[29]. This included but was not limited to the transformation of Objective Structured Clinical Examinations (OSCE[30]) into Multiple Choice tests.

Participants

All first year dental students (n=68) enrolled in the integrated dental degree program iMED DENT launched in 2019 and medical students (n=352) enrolled in the integrated medical degree program iMED established in 2012 at the Medical School of the University of Hamburg, Germany[31] were invited to participate in the online surveys. Students were asked to complete an anonymous questionnaire linked to the voluntary curriculum evaluation conducted by the dean's office in regular intervals during the course of the year. A few days in advance the students were informed via e-mail of the study aims, voluntary participation and data protection regulations. Participants did not receive any incentives for answering the questionnaire.

Measures

We developed an online questionnaire and focused on symptoms of distress, depression and anxiety and stress by using established self-reporting questionnaires. Furthermore, we assessed the perception of the study situation during the pandemic and study motivation with self-developed items. Demographic characteristics (age in categories, gender) were also self-reported.

Distress

We assessed students' distress at t1 (May 2020) and t2 (July 2020) using the German version of the Distress-Thermometer (DT), a brief screening instrument developed by the National Comprehensive Cancer Network (NCCN)[32]. The DT is a single-item instrument with a scale from 0-10. Higher scores indicate higher distress. Internationally a cutoff score of 4 is established as a signal that a person is distressed and needs support. The DT is a reliable and efficient screening instrument[32].

Depression and anxiety

We measured depression and anxiety using the German version of the four-item Patient Health Questionnaire (PHQ-4), an ultra-brief screening instrument that consists of a two-item depression scale (PHQ-2) and a two-item anxiety scale (GAD-2)[33]. It assesses the amount of depression and anxiety symptoms the individual has felt during the past two weeks. A score of 3 or higher on the PHQ-2 and GAD-2 is established as a reasonable cut-off score clinically relevant levels of depressive and anxiety symptoms. The total PHQ-4 score is considered as an overall measure of symptom burden with the following categories: 0-2 normal, 3-5 mild, 6-8 moderate, 9-12 severe. It is an efficient screening instrument with good internal consistency and construct validity and areas under the curve between 0.84 (anxiety) and 0.79 (depression) among students[34].

Changes in mental health and perception of study situation during the COVID-19 pandemic

Furthermore we administered five self-developed items to assess changes in students' mental health and perception of the study situation: Students were asked whether their mental health has changed since the beginning of the pandemic with five answer options (clearly improved; rather improved; unchanged; rather worsened; clearly worsened). They were asked if the assessment of their study situation has changed in the context of the pandemic with three answer options (No, I am as worried or unworried as before; Yes, I am somewhat worried; Yes, I am seriously worried). Furthermore

students were asked if the pandemic affected their possibility to participate in exams with five options to answer (No exams took place since the beginning of the pandemic; Exams took place without changes; Exams did not take place, but a new date is scheduled; Exams did not take place and no new date is scheduled yet; I was not able to attend exams due to quarantine or illness). Students were asked if their study motivation had changed since the beginning of the pandemic. Answers were rated on a 5-point Likert-type scale (clearly increased; rather increased; unchanged; rather decreased; clearly decreased). Finally, students were asked for free text responses regarding the question what currently is occupying them most in their current study situation and what they experience as particularly helpful.

Stress

In the second survey students' perception of stress was quantified with the Perceived Stress Scale (PSS-4). The 4-item self-report instrument with reverse coding for two items assesses on a five-point Likert scale the degree to which situations in one's life were perceived as stressful in the past month[35]. Higher scores on the PSS-4 indicate higher stress levels.

Burdening aspects

For the second data collection in July 2020, we developed six items based on the qualitative results from the first survey to assess burdening aspects experienced by the students' quantitatively. The respondents had the possibility to answer in four levels (1 = "not at all burdensome" to 4 = "very burdensome").

Data analysis

We matched dental students to medical students according to age and gender in the ratio of 1:2 in order to harmonize the initially inhomogeneous sample sizes and enhance comparability of the samples. In May 2020, the final sample consisted of n=132 students (44 dental and 88 medical students). In July 2020, the sample comprised 150 students (50 dental and 100 medical students). With 74% (t1) and 69% (t2) female students the gender ratio of the sample is comparable to the ratio of first year students at German medical schools[36]. We used descriptive statistics to characterize the sample. Group comparisons were carried out using chi^2-tests for categorical variables and t-tests for differences of means.

We conducted descriptive analyses to examine the magnitude of distress (DT), depression and anxiety (PHQ-4), and stress (PSS-4). The results of the entire sample as well as of the subgroups (dental and medical students) were compared with PHQ-4 data of a German medical student sample (n=321, mean age=21.8 years, 60.7% women) from a previous study at the same faculty[8] with one-sample t-tests. To examine the likelihood for serious worries (dichotomous) regarding the study situation during the COVID-19 pandemic at t1 we conducted a binary logistic regression model with sex, subject of study, the magnitude of distress, depression and anxiety as potential predictors. Non-significant variables were excluded via backward elimination and dropped at the level of $p < 0.05$. We applied likelihood ratio method, which is recommended for stepwise methods[37]. To avoid multicollinearity, we analyzed Variable Inflation Factors (VIF) scores. We conducted effect size calculations and considered according to Cohen's $f^2 = .02$ to be a small effect, $f^2 = .15$ as a medium effect, and $f^2 = .35$ as a large effect[38]. All quantitative analyses were carried out using IBM SPSS version 27.

We used conventional content analyses with inductive categorization to analyze the free text responses[39]. Two researchers familiarized themselves with the qualitative data (IH, JG). They identified key concepts and generated labels of codes for recurring themes independently. Next, both sorted codes into categories independently, which were reviewed by all authors. We developed final definitions for categories and codes with iterative consultations and discussions until consensus was achieved. We chose excerpts to exemplify each category and translated them into English. For the qualitative data analysis, we used MAXQDA 2020 (VERBI Software, 2019).

Following the inductive categorization we recoded answers for each category into dichotomous variables (mentioned vs. not mentioned) to enhance data transparency and to provide evidence for our interpretation[40]. When students provided more than one category per response, all responses respectively categories were categorized. The qualitative results of the first survey served as the basis for developing six quantitative items for the second survey.

The local ethics board of the Center for Psychosocial Medicine at the University Medical Center Hamburg-Eppendorf approved the study (LPEK-0161).

Patient and Public Involvement

We did not involve patients in our study. Research questions were developed by the principle investigators (CB, JG) and discussed with the Curriculumkommitee iMED, Hamburg (CK iMED) in April 2020. CK IMED is a committee consisting of students, teachers and a member of the dean's office, which has the task of further developing and optimizing the structure and content of the reformed medical degree program iMED. Subsequently all enrolled students were informed by e-mail about the design, conduct, the outcome measures and the recruitment and encouraged to give feedback. After

publication a summary of the results will be presented in plain language on the website of the University Medical Center Hamburg-Eppendorf.

RESULTS

Of 68 first year dental students enrolled in the dental education program at the UKE in May 2020, 44 (65.3%) completed the first survey (t1) in May 2020 and were matched to 88 medical first year students who completed the t1 survey as described above (overall response rate of the medical students was 87.2%). The response rate of the second survey (t2) was 81% among first year dental students and 82% among first year medical students. With 75.0% (t1) and 70.0% (t2) female dental students and 39.7% (t1) and 40.0% (t2) aged 20 years and younger, both samples are similar to the population of first year dental students at the faculty. The demographic characteristics of the final samples are shown in Table1.

Table 1: Sample characteristics among dental and medical students participating in the first (n^1=132) and second survey (n^2=150)

	First Survey (May 2020)			**Second Survey (July 2020)**		
	Whole sample (n=132)	**Dental students** (n_1=44)	**Medical students** (n_1=88)	**Whole sample** (n=150)	**Dental students** (n_2=50)	**Medical students** (n_2=100)
	%	%	%	%	%	%
sex:						
male	25.8	25.0	26.1	30.7	30.0	31.0
female	74.2	75.0	73.9	69.3	70.0	69.0
age:						
Up to 20 years	38.6	39.7	38.6	40.0	40.0	40.0
21-25 years	34.1	33.8	34.1	34.0	34.0	34.0
26-30 years	18.2	17.6	18.2	18.0	18.0	18.0
31-35 years	6.8	5.9	6.8	6.0	6.0	6.0
Older than 35 years	2.3	2.9	2.3	2.0	2.0	2.0

Distress, depression and anxiety

Overall, high levels of distress, anxiety and depression were found in both dental and medical students. Compared to a German reference sample [41] with an overall mean PHQ-4 score of 1.8 (SD=2.0) and of 1.5 (SD=2.0) for a student subsample, our samples reported on average significantly higher anxiety and depression (PHQ-4) scores at t1 and t2: In May 2020 79.5% of the dental students and 86.4% of the medical students reported moderate or severe distress scores and 25.0% of the dental students and 23.8% of the medical students reported moderate to severe anxiety and depression scores. In July

2020 dental students reported significantly higher levels of distress and anxiety than medical students (Table 2). With regard to gender differences, the scores of male and female students did overall not differ significantly in the whole sample at t1 and t2. However, female dental students (t1: M=4.7; SD=2.6; t2: M=4.6; SD=2.8) reported significantly higher PHQ-4 scores than male dental students (t1: M=2.8; SD= 1.5; t2: M=2.9; SD= 2.6) at t1 ($t(42)= -2.2$, $p=.031$) and t2 ($t(48)= -2.1$, $p= .043$).

In July 2020 (t2), dental students reported significantly higher scores of distress and anxiety than medical students, while both groups were comparable with regard to their overall anxiety and depression symptom burden (24.0% with moderate or severe symptoms in dental students, 19.0% in medical students). With regard to self-perceived stress (only assessed in the second survey), dental students reported higher stress levels than medical students (Table 2).

Table 2: Amount of self-reported distress, depression and anxiety and stress among dental and medical students in May 2020 (n^1=132) and July 2020 (n^2=150)

	May 2020						July 2020					
	Whole sample	**Dental students (n=44)**	**Medical students (n=88)**				**Whole sample**	**Dental students (n=50)**	**Medical students (n=100)**			
	M (SD)	**M (SD)**	**M (SD)**	**t**	**df**	***p***	**M (SD)**	**M (SD)**	**M (SD)**	**t**	**df**	***p***
Distress (range: 0-10)	6.4 (2.4)	6.3 (2.5)	6.5 (2.4)	0.31	130	.757	6.1 (2.2)	7.0 (2.3)	5.7 (2.1)	-3.57	148	**<.001**
Anxiety and depression (PHQ-4; range 0-12)	3.9 (2.5)	4.2 (2.5)	3.8 (2.5)	0.82	130	.417	3.7 (2.7)	4.1 (2.8)	3.6 (2.6)	1.13	148	.262
Anxiety (GAD-2; range 0-6)	1.9 (1.5)	2.1 (1.5)	1.9 (1.5)	0.79	130	.435	1.9 (1.6)	2.3 (1.8)	1.7 (1.4)	2.03	148	**.045**
Depression (PHQ-2; range 0-6)	2.0 (1.3)	2.1 (1.3)	1.9 (1.3)	0.66	130	.513	1.8 (1.4)	1.8 (1.3)	1.8 (1.4)	-0.13	148	.898
Self-perceived Stress (PSS-4; range 0-16)	-	-	-	-	-	-	5.6 (3.1)	6.1 (3.2)	5.3 (2.9)	1.53	148	.128
Anxiety and depression symptoms (PHQ4)	**%**	**%**	**%**	**chi²**	**df**	***p***	**%**	**%**	**%**	**chi²**	**df**	***p***
normal (0-2)	31.8	25.0	35.2	1.54	3	.674	38.0	36.0	39.0	0.56	3	.906
mild (3-5)	43.9	50.0	40.9				41.3	40.0	42.0			
moderate (6-8)	19.7	20.5	19.3				13.3	16.0	12.0			
severe (9-12)	4.5	4.5	4.5				7.3	8.0	7.0			
Distress by category	**%**	**%**	**%**	**chi²**	**df**	***p***	**%**	**%**	**%**	**chi²**	**df**	***p***
Normal (0-4)	15.9	20.5	13.6	1.02	2	.600	22.7	16.0	26.0	9.65	2	**.008**
Moderate (5-7)	50.8	47.7	52.3				49.3	40.0	54.0			
Severe (8-10)	33.3	31.8	34.1				28.0	44.0	20.0			
Over cutoff (≥5)	84.1	79.5	86.4	1.02	1	.313	77.3	84.0	74.0	1.90	1	.168

Note. n=number; M = mean; SD = standard deviation; df = degrees of freedom; *p* = *p*-value, significance level *p*<.05

Changes in mental health and perception of the study situation

Overall, about one third of the students (36.4% dental students vs. 29.5% medical students) reported that their mental health had worsened because of the pandemic at t1**.** Likewise, a total of 35.6% (45.5% dental vs. 30.7% medical students) reported a decrease in their study motivation at t1 and 36.7% at t2 (36.0% dental vs. 37.0% medical students). With regard to worries about the current study situation more medical students (t1: 46.4%; t2: 47.5%) than dental students (t1: 31.8%; t2: 34.7%) reported to be unperturbed and slightly more dental than medical students were seriously worried at t1 (18.2% vs. 6.0%) and at t2 (14.3% vs. 10.1%). However, in both surveys dental and medical students did not differ statistically significant regarding their self-reported changes of mental health, study motivation or worries about the current study situation (Table 3). Likewise, we did not find statistically significant differences between male and female students.

Table 3: Perception of current study situation, changes of self-reported mental health caused by the COVID-19 pandemic and changes of study motivation of dental and medical students in May 2020 (n^1=132) and July 2020 (n^2=150)

	May 2020						July 2020					
Worries about current study situation	**Whole sample (129<n<132)**	**Dental students (n=44)**	**Medical students (84<n>88)**				**Whole sample (148<n<150)**	**Dental students (49<n>50)**	**Medical students (99<n>100)**			
	%	**%**	**%**	**chi²**	**df**	***p***	**%**	**%**	**%**	**chi²**	**df**	***p***
Not worried	41.4	31.8	46.4	5.77	2	.056	43.2	34.7	47.5	2.27	2	.321
Somewhat worried	48.4	50.0	47.6				45.3	51.0	42.4			
Seriously worried	10.2	18.2	6.0				11.5	14.3	10.1			
Self-reported changes of mental health caused by the COVID-19 pandemic												
improved	19.7	22.7	18.2	1.52	2	.468	Not asked.					
unchanged	48.5	40.9	52.3									
worsened	31.8	36.4	29.5									
Self-reported changes of study motivation												
increased	13.6	11.4	14.8	2.79	2	.247	16.0	16.0	16.0	0.02	2	.992
unchanged	50.8	43.2	54.5				47.3	48.0	47.0			
decreased	35.6	45.5	30.7				36.7	36.0	37.0			
Burdening aspects[1]	Not asked						**Whole sample**	**Dental students (49<n>50)**	**Medical students (99<n>100)**	**chi²**	**df**	***p***
Preparation for (final) exams	-	-	-	-	-	-	63.3	76.0	57.0	5.18	1	**.023**
Lack of practical training	-	-	-				43.3	52.0	39.0	2.29	1	.130
Few social contacts (private)	-	-	-				43.3	34.0	48.0	2.66	1	.103
Lack of interaction with fellow students	-	-	-	-	-	-	56.0	52.0	58.0	0.49	1	.485
Concomitants of the CoViD-19 pandemic (contact restrictions, mandatory facemasks, etc.)	-	-	-				22.0	24.0	21.0	0.18	1	.676
General uncertainty	-	-	-				36.0	54.0	27.0	10.55	1	**.001**

Note: n=number; M = mean; SD = standard deviation; df = degrees of freedom; *p* = *p*-value, significance level *p*<.05

[1]dichotomized: burdened (s. Table above) including “somewhat burdensome” and “very burdensome” vs. not burdened including “not at all burdensome” and “a little burdensome”

Burdening aspects

Many of students felt burdened due to the lack of interaction with fellow students. In comparison to medical students, significantly more dental students stated that they were burdened with regard to the exams and the general uncertainty (Table 3).

Binary logistic regression indicated that medical students were significantly more likely to experience serious worries regarding the current study situation during COVID-19 than dental students at t1. At t2 higher distress was associated with a higher likelihood for reporting serious worries regarding the current study situation during COVID-19 (Table 4).

Table 4: Binary logistic regression models on the association of study subject, depression and distress with serious worries in dental and medical students during the COVID-19 pandemic.

May 2020	**Odds ratio (OR)**	**95% confidence interval (CI)**	***p***	***effect size*[1]**
Subject of study				
dental	4.0		n.a.	
medical	Reference	1.1 – 14.2	**.031**	.032
Distress (DT)	1.4	0.9 -1.9	.078	
Depression symptoms (PHQ-2)	1.5	0.9 - 2.6	.091	
July 2020				
Distress (DT)	1.8	1.3 – 2.5	**.001**	0.24

[1]According to Cohen's guidelines (1988) we considered f^2= .02 to be a small effect, f^2=.15 as a medium effect, and f^2=.35 as a large effect.

Current concerns and helpful aspects

A total of 52 students (39.4%) provided optional free-text responses regarding the question "What is currently occupying you most in your current study situation?". We identified five categories in a multistage inductive process. The most frequent categories were "difficulties with self-regulated learning and self-motivation", followed by "study-related worries and uncertainty", "lack of feedback from other students and lecturers" and "lack of practical training". Significantly more dental (20.5%) than medical students (4.5%) reported concerns about the lack of practical training (chi² = 8.4; df = 1; *p*=.004) (Table 5).

Table 5: Categories, examples and quantified responses by category for the questions "What is currently occupying you most in your current study situation?" in May 2020 (n=132)

What is currently occupying you most?		Whole sample (n=132) mentioned	Dental students (n=44) mentioned	Medical students (n=88) mentioned			
Category and subcategory	**Example**	**%**	**%**	**%**	**Chi²**	**df**	***p***
Difficulties with self-regulated learning (n = 20; 15.2%) • Self-Motivation • Difficulties with new learning environment	"Self-motivation- the exchange with fellow students and lecturers is missing, and therefore one has to motivate oneself every day anew to sit down at home (the library as a room for studying is also missing) and to motivate oneself to nevertheless 'attend' all study courses in time and to catch up on the study-work." "Since I don't have the proper learning environment at home, I found it difficult to learn the very extensive content in an appropriate manner."	15.2	15.9	14.8	0.03	1	.864
Study-related worries and uncertainty (n = 19; 14.4%) • Concerns to perform worse/ to fail • Study-related uncertainty	"Extreme pressure to teach myself the mass of content in a short time through e-learning in order to succeed on the exam." "The uncertainty of if and when face-to-face classes can be held again, and if potentially my study time will be extended due to this pandemic."	14.4	20.5	11.4	1.97	1	.161

Lack of feedback from other students and lecturers (n = 15; 11.4%)	"Due to the online format, the exchange with fellow students and the lecturers is missing. (…)."	11.4	11.4	11.4	0.00	1	1.000
Lack of practical training (n = 13; 9.8%)	"The practical components in dental education are essential and (...) are now being cancelled. (…)"	9.8	20.5	4.5	8.36	1	**.004**
Other (n = 9; 6.8%)	"Lack of available childcare. Learning with (...) children at home is a challenge."	6.8	11.4	4.5	2.15	1	.143

Note: n=number; df = degrees of freedom; *p* = *p*-value, significance level *p*<.05

Furthermore, 53 students (40.2%) completed optional free-text responses to the question "What do you currently experience as particularly helpful?". Again five categories were identified through a multi-step inductive process. The most common categories were "Exchange with other students and lecturers", followed by "flexibility due to online lessons", "self-regulation, -motivation and -structuring", and "balance through sports and leisure". Dental and medical students did not differ significantly in their answers with regard to helpful aspects (Table 6).

Table 6: Categories, examples and quantified responses by category for the questions "What do you currently experience as particularly helpful?" in May 2020 (n=132)

What do you currently experience as particularly helpful?		Whole sample (n=132) mentioned	Dental students (n=44) mentioned	Medical students (n=88) mentioned			
Category	**Example**	**%**	**%**	**%**	**Chi²**	**df**	***p***
Exchange with students and lecturers (n = 18; 13.6%)	"Intensive exchange with fellow students and lecturers."	13.6	15.9	12.5	0.29	1	.591
Flexibility due to online lessons (n = 17; 12.9%)	"The online semester also brings many advantages. You can arrange everything yourself and work at your own pace. This also takes away a lot of stress for me personally (...)"	12.9	15.9	11.4	0.54	1	.462
Structure and self-discipline (n = 13; 9.8%)	"Studying online to regain routine in everyday life."	9.8	11.4	9.1	0.17	1	.680
Balance through sports and leisure (n = 11; 8.3%)	"The fact that I can do my team sports again, that gives me enough variety and distraction "	8.3	11.4	6.8	0.79	1	.373
Other (n = 9; 6.8%)	"Encouragement of friends and family"	6.8	9.1	5.7	0.54	1	.464

Note: n=number; df = degrees of freedom; *p* = *p*-value, significance level *p*<.05

DISCUSSION

This study investigated the mental burden and study situation among undergraduate dental and medical students after the initial stage of the COVID-19 pandemic from May 2020 to July 2020. In line with previous studies conducted before the pandemic dental and medical students reported high levels of distress, anxiety and depression[8, 12, 42]. Compared to the norm population students of both professions reported significantly higher levels of anxiety and depression, consistent with findings of other studies[8, 43]. In light of the COVID-19 pandemic, the presence of additional pandemic specific stressors is likely[22]. A recent study showed that for most students isolation from student social networks is associated with increased anxiety levels[24]. According to our qualitative data, the lack of direct contact with fellow students, which could only take place via online media, affects both student professions negatively. For dental students, the lack of practical training played a major role, as dentists usually take dental courses from the first semester onwards to learn the practical skills from early stage on[44]. In comparison, this issue does not yet affect medical students as much in the early stages of their studies, as the undergraduate medical curriculum in Germany includes fewer practical training during this time[45]. In sum this probably accounts for our findings that reported levels of anxiety and depression are even higher than among students of the same medical school prior to the Corona pandemic[8].

With regard to the study situation, medical and in particular dental students were concerned about their current study situation. This trend continued in the further course of the pandemic. These results corroborate recent findings in a representative sample in Austria with a notable decline in mental health during the pandemic[46].

In line with the findings of Stangvaltaite-Mouhat et al. (2020) female dental students showed more pronounced anxiety symptoms than male dental students in our study[11]. This underlines that mental burden may be higher among female students in general[47]. Recent studies also suggest that women are particular burdened during the COVID-19 pandemic[46, 48, 49, 50, 51]. Furthermore several studies showed that certain age groups, including individuals between 18 and 25 years old - the most common age group in students - suffered more from mental distress[46, 48, 50, 52]. Qiu et al. (2020) suspect social media to be one of the causes[48]. Previous research seems to confirm this hypothesis as younger people tend to receive a large amount of information via social media, which can easily trigger stress[53]. The easy accessibility and constant presence of pandemic information may lead to an increase in the duration of information consumption. This increasing duration reinforces the potential negative influence on mental health[54]. A noteworthy finding is that dental students reported increased levels of distress, anxiety and more worries in the second survey whereas medical students' scores were slightly lower at the second survey.

There are some limitations of our study. The cross-sectional surveys at two different times do not allow causal statements about longitudinal developments. The small sample size limits representativeness. However, due to the high response rates (65-87% in the first and 81-82% in the second survey) one may assume that a majority of the respondents participated in both surveys. Thus, these single-institutional and cross-sectional surveys achieve a high level of comparability and representativeness. Still there was a considerable proportion of students that did not participate in the surveys, which might lead to a volunteer bias[55]. Nonvolunteers may encompass students who suffer from high levels of distress, anxiety and/or depression. Thus some of the parameters reported in the study may be underestimating the true burden.

Furthermore, no comparisons can be made with the situation before the outbreak of the pandemic, among the same population. Nevertheless, the study by Heinen et al. (2017) conducted at the same medical school with the same measures serves as a valid context to frame our findings[8].

Considering the worsened levels of psychological distress among students during the COVID-19 pandemic [56, 57] academic institutions should provide timely services in terms of tailored interventions, which address the specific worries of dental and medical students. Other authors already provided valuable and concrete recommendations how to reduce the impact of COVID-19 on student-athlete mental health [58, 59]. Grubic et al. (2021) proposed a framework to manage student-athlete mental health during the pandemic including “goal setting/motivation” and “support system/social network” as potential positive influencers. These aspects could be addressed by medical schools in the form of mentoring. Mentoring was identified as valuable intervention for undergraduate medical students due to its association with improved emotional well-being of students before the pandemic[60]. During the pandemic a novel near-peer mentoring intervention via social media was reported with promising first results[61]. Thus, the implementation of mentoring at medical schools or the transfer of existing mentoring interventions digital formats might help to reduce the negative impact of the COVID-19 pandemic on dental and medical students. At the same time longitudinal research is needed to monitor the mental health of students during the pandemic and after as well as rigor evaluation of all interventions.

Conclusion

Overall students of medicine and dentistry are particularly affected by high mental distress and burden due to the demanding contents and structure of their studies. It is likely that the concomitant symptoms of the pandemic have an additional negative impact on the levels of stress, anxiety and depression of the students.

Especially dental students reported higher levels of burden which might be associated with the high practical content early in their studies. The increase in anxiety levels of dental students might be

associated with the duration of the restrictions of especially the practical content during the undergraduate study. Against this background, further monitoring of both dental and medical students during the pandemic would be important in order to develop and introduce tailored prevention concepts adapted to the specific study situation.

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Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1

Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5

Bias	#9	Describe any efforts to address potential sources of bias	7
Study size	#10	Explain how the study size was arrived at	4
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	6
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	6
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	6
Statistical methods	#12c	Explain how missing data were addressed	4
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	n/a
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	7
Participants	#13b	Give reasons for non-participation at each stage	n/a

Participants	#13c	Consider use of a flow diagram	n/a
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	7-8
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	9; 11
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	n/a
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
Main results	#16b	Report category boundaries when continuous variables were categorized	9
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	#18	Summarise key results with reference to study objectives	17

Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	18
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	18
Generalisability	#21	Discuss the generalisability (external validity) of the study results	18
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

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Mental burden and perception of the study situation among undergraduate students during the COVID-19 pandemic: a cross-sectional study and comparison of dental and medical students

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ABSTRACT

Objectives: To investigate levels of distress, depression, anxiety, stress and perception of their current study situation during the COVID-19 pandemic among undergraduate dental and medical students.

Design: Observational, cross-sectional study including two consecutive surveys (May and July 2020).

Setting: A large medical school in Germany.

Participants: All first year dental and medical students were invited. 132 participating first year students (44 dental, 88 medical) from the first survey and 150 students (50 dental, 100 medical) from the second were included in our analyses.

Primary and secondary outcome measures: Mental burden (Distress Thermometer, Patient Health Questionnaire PHQ-4, Perceived Stress Scale, PSS-4) and self-reported changes in mental health and perception of study situation during the COVID-19 pandemic (self-developed items) were compared. Open-ended questions were analyzed by conventional content analyses.

Results: A considerable proportion of students (t1: May 2020: 84.1%; t2: July 2020: 77.3%) reported distress levels above cutoff. In July 2020, dental students reported significantly higher distress scores than medical students (dental: M=7.0, SD=2.3; medical: M=5.7; SD=2.1; p<.001). More dental than medical students reported mild, moderate and severe levels of anxiety and depression symptoms. The majority stated that their mental health and study motivation had not changed during the pandemic. Logistic regression showed that being a dental student was significantly associated with a higher likelihood for serious worries regarding the study situation during COVID-19 at t1 (OR: 4.0; CI (95%): 1.1 – 14.2). At t2 higher distress was significantly associated with a higher likelihood for experiencing serious worries (OR: 1.8; CI (95%): 1.3 – 2.5). Regarding current concerns related to the pandemic, students most frequently reported difficulties with self-regulated learning (15.2%), study-related worries and uncertainty (14.4%), missing feedback of students and lecturers (11.4%) and lack of practical training (9.8%).

Conclusion: The results suggest that high mental burden and the lack of practical training among medical and dental students is an increasing problem, with a possibly even higher urgency in dental students. Tailored psychological and educational support offers during and after the COVID-19 pandemic might help them as they progress through (medical and) dental school.

Strengths and limitations of this study

- This study offers in-depth exploration of students' mental health and perception of their study situation during the COVID-19 pandemic by combining quantitative data and qualitative data

- This study included well-established and valid instruments (quantitative data) and applied conventional content analyses with inductive categorization (qualitative data).
- Response rates of this study were high (65.3% - 87.2%).
- It is a single-institution study and the cross-sectional design does not allow causal statements about longitudinal developments.

INTRODUCTION

The corona virus disease (COVID-19) pandemic and its consequences have an impact on the private, professional and social life of all people[1]. It has brought widespread disruption to undergraduate medical education[2, 3]. Thus medical students worldwide face major changes regarding their medical training and study motivation decreased[4]. Many medical schools have made changes to their curricula and campus life to protect patients and students by social distancing. Roles of medical students' during the COVID-19 pandemic are discussed controversial[5]. Even in the absence of the COVID-19 pandemic, mental burden is common among medical students[6, 7, 8] and several studies report lower mental health outcomes for medical students in the course of their medical studies compared to population reference samples[9]. In particular, depression and anxiety symptoms are reported among medical[7, 10] and dental students[11-13]. Often students feel that they do not have adequate coping strategies to deal with study-related workload and stress[14]. Dental students are highly stressed and perform at a comparable or higher stress level than medical students[15]. Studies have shown that the stress level increases with each semester, especially due to the high proportion of practical training in dental studies[13, 16].

In light of novel circumstances during the COVID-19 pandemic, uncertainty relating to personal and professional future and rapid changes medical students may be even more at risk of experiencing severe mental burden during the pandemic than before. Increased incidence rates of stress and mental burden are an expected response under the current conditions[17].

Studies have shown the negative impact of past pandemics[18] and the COVID-19 pandemic[19] on the general population, as well as on specific groups[20]. Health professionals may be particularly affected[21], as pandemic-specific stressors are added to the general ones[22]. High prevalence for mental health symptoms among health care workers exposed to COVID-19 was found[20]. Students are also highly burdened while facing new challenges raised by the pandemic's consequences[23, 24]. COVID-19 related mental stress, higher rates of depression and a high symptom burden from the acute stress response according to the COVID-19 pandemic are common especially among health care students[25], as they have to cope with mental and emotional issues, including stress and anxiety.

In contrast to the exposure of students in general during the COVID-19 pandemic, the mental burden of medical and dental students in particular is still poorly addressed in the international literature even though they are facing special challenges in health care[26].

Therefore, the aim of this study was to assess the magnitude of distress, depression and anxiety and stress among undergraduate dental and medical students in the course of the COVID-19 pandemic. Secondly, we aimed to explore students' perception of the study situation during the pandemic and compare dental and medical students' perception during the first lockdown period and thereafter.

METHODS

Design and setting

This observational study consists of two cross-sectional surveys conducted at the University Medical Center Hamburg-Eppendorf, Germany, from May 28, 2020 to June 7 (t1), 2020 and from July 16, 2020 to July 31, 2020 (t2). During this period and before (since mid-March 2020) the German government announced several public health measures to suppress the spread of COVID-19 by increasing social distancing, i.e. the closure of schools, daycare, playgrounds and non-essential shops, the prohibition to meet more than one person from another household and depending on regional regulations the prohibition to leave the apartment without reason[27]. Concurrently lectures and seminars at the universities were predominantly held in a digital format to reduce interpersonal contact and to protect patients, students and faculty[28]. Thus, the learning environment and examination conditions for students have changed significantly. Many medical schools have discontinued their undergraduate medical training and transitioned most of their teaching to digital formats[29]. This included but was not limited to the transformation of Objective Structured Clinical Examinations (OSCE[30]) into Multiple Choice tests.

Participants

All first year dental students (n=68) enrolled in the integrated dental degree program iMED DENT launched in 2019 and medical students (n=352) enrolled in the integrated medical degree program iMED established in 2012 at the Medical School of the University of Hamburg, Germany[31] were invited to participate in the online surveys. Students were asked to complete an anonymous questionnaire linked to the voluntary curriculum evaluation conducted by the dean's office in regular intervals during the course of the year. A few days in advance the students were informed via e-mail of the study aims, voluntary participation and data protection regulations. Participants did not receive any incentives for answering the questionnaire.

Measures

We developed an online questionnaire and focused on symptoms of distress, depression and anxiety and stress by using established self-reporting questionnaires. Furthermore, we assessed the perception of the study situation during the pandemic and study motivation with self-developed items. Demographic characteristics (age in categories, gender) were also self-reported.

Distress

We assessed students' distress at t1 (May 2020) and t2 (July 2020) using the German version of the Distress-Thermometer (DT), a brief screening instrument developed by the National Comprehensive Cancer Network (NCCN)[32]. The DT is a single-item instrument with a scale from 0-10. Higher scores indicate higher distress. Internationally a cutoff score of 4 is established as a signal that a person is distressed and needs support. The DT is a reliable and efficient screening instrument[32].

Depression and anxiety

We measured depression and anxiety using the German version of the four-item Patient Health Questionnaire (PHQ-4), an ultra-brief screening instrument that consists of a two-item depression scale (PHQ-2) and a two-item anxiety scale (GAD-2)[33]. It assesses the amount of depression and anxiety symptoms the individual has felt during the past two weeks. A score of 3 or higher on the PHQ-2 and GAD-2 is established as a reasonable cut-off score clinically relevant levels of depressive and anxiety symptoms. The total PHQ-4 score is considered as an overall measure of symptom burden with the following categories: 0-2 normal, 3-5 mild, 6-8 moderate, 9-12 severe. It is an efficient screening instrument with good internal consistency and construct validity and areas under the curve between 0.84 (anxiety) and 0.79 (depression) among students[34].

Changes in mental health and perception of study situation during the COVID-19 pandemic

Furthermore we administered five self-developed items to assess changes in students' mental health and perception of the study situation: Students were asked whether their mental health has changed since the beginning of the pandemic with five answer options (clearly improved; rather improved; unchanged; rather worsened; clearly worsened). They were asked if the assessment of their study situation has changed in the context of the pandemic with three answer options (No, I am as worried or unworried as before; Yes, I am somewhat worried; Yes, I am seriously worried). Furthermore

students were asked if the pandemic affected their possibility to participate in exams with five options to answer (No exams took place since the beginning of the pandemic; Exams took place without changes; Exams did not take place, but a new date is scheduled; Exams did not take place and no new date is scheduled yet; I was not able to attend exams due to quarantine or illness). Students were asked if their study motivation had changed since the beginning of the pandemic. Answers were rated on a 5-point Likert-type scale (clearly increased; rather increased; unchanged; rather decreased; clearly decreased). Finally, students were asked for free text responses regarding the question what currently is occupying them most in their current study situation and what they experience as particularly helpful.

Stress

In the second survey students' perception of stress was quantified with the Perceived Stress Scale (PSS-4). The 4-item self-report instrument with reverse coding for two items assesses on a five-point Likert scale the degree to which situations in one's life were perceived as stressful in the past month[35]. Higher scores on the PSS-4 indicate higher stress levels.

Burdening aspects

For the second data collection in July 2020, we developed six items based on the qualitative results from the first survey to assess burdening aspects experienced by the students' quantitatively. The respondents had the possibility to answer in four levels (1 = "not at all burdensome" to 4 = "very burdensome").

Data analysis

We matched dental students to medical students according to age and gender in the ratio of 1:2 in order to harmonize the initially inhomogeneous sample sizes and enhance comparability of the samples. In May 2020, the final sample consisted of n=132 students (44 dental and 88 medical students). In July 2020, the sample comprised 150 students (50 dental and 100 medical students). With 74% (t1) and 69% (t2) female students the gender ratio of the sample is comparable to the ratio of first year students at German medical schools[36]. We used descriptive statistics to characterize the sample. Group comparisons were carried out using chi^2-tests for categorical variables and t-tests for differences of means.

We conducted descriptive analyses to examine the magnitude of distress (DT), depression and anxiety (PHQ-4), and stress (PSS-4). The results of the entire sample as well as of the subgroups (dental and medical students) were compared with PHQ-4 data of a German medical student sample (n=321, mean age=21.8 years, 60.7% women) from a previous study at the same faculty[8] with one-sample t-tests. To examine the likelihood for serious worries (dichotomous) regarding the study situation during the COVID-19 pandemic at t1 we conducted a binary logistic regression model with sex, subject of study, the magnitude of distress, depression and anxiety as potential predictors. Non-significant variables were excluded via backward elimination and dropped at the level of $p < 0.05$. We applied likelihood ratio method, which is recommended for stepwise methods[37]. To avoid multicollinearity, we analyzed Variable Inflation Factors (VIF) scores. We conducted effect size calculations and considered according to Cohen's $f^2 = .02$ to be a small effect, $f^2 = .15$ as a medium effect, and $f^2 = .35$ as a large effect[38]. All quantitative analyses were carried out using IBM SPSS version 27.

We used conventional content analyses with inductive categorization to analyze the free text responses[39]. Two researchers familiarized themselves with the qualitative data (IH, JG). They identified key concepts and generated labels of codes for recurring themes independently. Next, both sorted codes into categories independently, which were reviewed by all authors. We developed final definitions for categories and codes with iterative consultations and discussions until consensus was achieved. We chose excerpts to exemplify each category and translated them into English. For the qualitative data analysis, we used MAXQDA 2020 (VERBI Software, 2019).

Following the inductive categorization we recoded answers for each category into dichotomous variables (mentioned vs. not mentioned) to enhance data transparency and to provide evidence for our interpretation[40]. When students provided more than one category per response, all responses respectively categories were categorized. The qualitative results of the first survey served as the basis for developing six quantitative items for the second survey.

The local ethics board of the Center for Psychosocial Medicine at the University Medical Center Hamburg-Eppendorf approved the study (LPEK-0161).

Patient and Public Involvement

We did not involve patients in our study. Research questions were developed by the principle investigators (CB, JG) and discussed with the Curriculumkommitee iMED, Hamburg (CK iMED) in April 2020. CK IMED is a committee consisting of students, teachers and a member of the dean's office, which has the task of further developing and optimizing the structure and content of the reformed medical degree program iMED. Subsequently all enrolled students were informed by e-mail about the design, conduct, the outcome measures and the recruitment and encouraged to give feedback. After

publication a summary of the results will be presented in plain language on the website of the University Medical Center Hamburg-Eppendorf.

RESULTS

Of 68 first year dental students enrolled in the dental education program at the UKE in May 2020, 44 (65.3%) completed the first survey (t1) in May 2020 and were matched to 88 medical first year students who completed the t1 survey as described above (overall response rate of the medical students was 87.2%). The response rate of the second survey (t2) was 81% among first year dental students and 82% among first year medical students. With 75.0% (t1) and 70.0% (t2) female dental students and 39.7% (t1) and 40.0% (t2) aged 20 years and younger, both samples are similar to the population of first year dental students at the faculty. The demographic characteristics of the final samples are shown in Table1.

Table 1: Sample characteristics among dental and medical students participating in the first (n^1=132) and second survey (n^2=150)

	First Survey (May 2020)			**Second Survey (July 2020)**		
	Whole sample (n=132)	**Dental students** (n_1=44)	**Medical students** (n_1=88)	**Whole sample** (n=150)	**Dental students** (n_2=50)	**Medical students** (n_2=100)
	%	%	%	%	%	%
sex:						
male	25.8	25.0	26.1	30.7	30.0	31.0
female	74.2	75.0	73.9	69.3	70.0	69.0
age:						
Up to 20 years	38.6	39.7	38.6	40.0	40.0	40.0
21-25 years	34.1	33.8	34.1	34.0	34.0	34.0
26-30 years	18.2	17.6	18.2	18.0	18.0	18.0
31-35 years	6.8	5.9	6.8	6.0	6.0	6.0
Older than 35 years	2.3	2.9	2.3	2.0	2.0	2.0

Distress, depression and anxiety

Overall, high levels of distress, anxiety and depression were found in both dental and medical students. Compared to a German reference sample [41] with an overall mean PHQ-4 score of 1.8 (SD=2.0) and of 1.5 (SD=2.0) for a student subsample, our samples reported on average significantly higher anxiety and depression (PHQ-4) scores at t1 and t2: In May 2020 79.5% of the dental students and 86.4% of the medical students reported moderate or severe distress scores and 25.0% of the dental students and 23.8% of the medical students reported moderate to severe anxiety and depression scores. In July

2020 dental students reported significantly higher levels of distress and anxiety than medical students (Table 2). With regard to gender differences, the scores of male and female students did overall not differ significantly in the whole sample at t1 and t2. However, female dental students (t1: M=4.7; SD=2.6; t2: M=4.6; SD=2.8) reported significantly higher PHQ-4 scores than male dental students (t1: M=2.8; SD= 1.5; t2: M=2.9; SD= 2.6) at t1 ($t(42)= -2.2$, $p=.031$) and t2 ($t(48)= -2.1$, $p= .043$).

In July 2020 (t2), dental students reported significantly higher scores of distress and anxiety than medical students, while both groups were comparable with regard to their overall anxiety and depression symptom burden (24.0% with moderate or severe symptoms in dental students, 19.0% in medical students). With regard to self-perceived stress (only assessed in the second survey), dental students reported higher stress levels than medical students (Table 2).

Table 2: Amount of self-reported distress, depression and anxiety and stress among dental and medical students in May 2020 (n^1=132) and July 2020 (n^2=150)

	May 2020						July 2020					
	Whole sample	**Dental students (n=44)**	**Medical students (n=88)**				**Whole sample**	**Dental students (n=50)**	**Medical students (n=100)**			
	M (SD)	**M (SD)**	**M (SD)**	**t**	**df**	***p***	**M (SD)**	**M (SD)**	**M (SD)**	**t**	**df**	***p***
Distress (range: 0-10)	6.4 (2.4)	6.3 (2.5)	6.5 (2.4)	0.31	130	.757	6.1 (2.2)	7.0 (2.3)	5.7 (2.1)	-3.57	148	**<.001**
Anxiety and depression (PHQ-4; range 0-12)	3.9 (2.5)	4.2 (2.5)	3.8 (2.5)	0.82	130	.417	3.7 (2.7)	4.1 (2.8)	3.6 (2.6)	1.13	148	.262
Anxiety (GAD-2; range 0-6)	1.9 (1.5)	2.1 (1.5)	1.9 (1.5)	0.79	130	.435	1.9 (1.6)	2.3 (1.8)	1.7 (1.4)	2.03	148	**.045**
Depression (PHQ-2; range 0-6)	2.0 (1.3)	2.1 (1.3)	1.9 (1.3)	0.66	130	.513	1.8 (1.4)	1.8 (1.3)	1.8 (1.4)	-0.13	148	.898
Self-perceived Stress (PSS-4; range 0-16)	-	-	-	-	-	-	5.6 (3.1)	6.1 (3.2)	5.3 (2.9)	1.53	148	.128
Anxiety and depression symptoms (PHQ4)	**%**	**%**	**%**	**chi²**	**df**	***p***	**%**	**%**	**%**	**chi²**	**df**	***p***
normal (0-2)	31.8	25.0	35.2	1.54	3	.674	38.0	36.0	39.0	0.56	3	.906
mild (3-5)	43.9	50.0	40.9				41.3	40.0	42.0			
moderate (6-8)	19.7	20.5	19.3				13.3	16.0	12.0			
severe (9-12)	4.5	4.5	4.5				7.3	8.0	7.0			
Distress by category	**%**	**%**	**%**	**chi²**	**df**	***p***	**%**	**%**	**%**	**chi²**	**df**	***p***
Normal (0-4)	15.9	20.5	13.6	1.02	2	.600	22.7	16.0	26.0	9.65	2	**.008**
Moderate (5-7)	50.8	47.7	52.3				49.3	40.0	54.0			
Severe (8-10)	33.3	31.8	34.1				28.0	44.0	20.0			
Over cutoff (≥5)	84.1	79.5	86.4	1.02	1	.313	77.3	84.0	74.0	1.90	1	.168

Note. n=number; M = mean; SD = standard deviation; df = degrees of freedom; *p* = *p*-value, significance level *p*<.05

Changes in mental health and perception of the study situation

Overall, about one third of the students (36.4% dental students vs. 29.5% medical students) reported that their mental health had worsened because of the pandemic at t1**.** Likewise, a total of 35.6% (45.5% dental vs. 30.7% medical students) reported a decrease in their study motivation at t1 and 36.7% at t2 (36.0% dental vs. 37.0% medical students). With regard to worries about the current study situation more medical students (t1: 46.4%; t2: 47.5%) than dental students (t1: 31.8%; t2: 34.7%) reported to be unperturbed and slightly more dental than medical students were seriously worried at t1 (18.2% vs. 6.0%) and at t2 (14.3% vs. 10.1%). However, in both surveys dental and medical students did not differ statistically significant regarding their self-reported changes of mental health, study motivation or worries about the current study situation (Table 3). Likewise, we did not find statistically significant differences between male and female students.

Table 3: Perception of current study situation, changes of self-reported mental health caused by the COVID-19 pandemic and changes of study motivation of dental and medical students in May 2020 (n^1=132) and July 2020 (n^2=150)

	May 2020						July 2020					
Worries about current study situation	**Whole sample (129<n<132)**	**Dental students (n=44)**	**Medical students (84<n>88)**				**Whole sample (148<n<150)**	**Dental students (49<n>50)**	**Medical students (99<n>100)**			
	%	**%**	**%**	**chi²**	**df**	***p***	**%**	**%**	**%**	**chi²**	**df**	***p***
Not worried	41.4	31.8	46.4	5.77	2	.056	43.2	34.7	47.5	2.27	2	.321
Somewhat worried	48.4	50.0	47.6				45.3	51.0	42.4			
Seriously worried	10.2	18.2	6.0				11.5	14.3	10.1			
Self-reported changes of mental health caused by the COVID-19 pandemic												
improved	19.7	22.7	18.2	1.52	2	.468	Not asked.					
unchanged	48.5	40.9	52.3									
worsened	31.8	36.4	29.5									
Self-reported changes of study motivation												
increased	13.6	11.4	14.8	2.79	2	.247	16.0	16.0	16.0	0.02	2	.992
unchanged	50.8	43.2	54.5				47.3	48.0	47.0			
decreased	35.6	45.5	30.7				36.7	36.0	37.0			
Burdening aspects[1]	Not asked						**Whole sample**	**Dental students (49<n>50)**	**Medical students (99<n>100)**	**chi²**	**df**	***p***
Preparation for (final) exams	-	-	-	-	-	-	63.3	76.0	57.0	5.18	1	**.023**
Lack of practical training	-	-	-				43.3	52.0	39.0	2.29	1	.130
Few social contacts (private)	-	-	-				43.3	34.0	48.0	2.66	1	.103
Lack of interaction with fellow students	-	-	-	-	-	-	56.0	52.0	58.0	0.49	1	.485
Concomitants of the CoViD-19 pandemic (contact restrictions, mandatory facemasks, etc.)	-	-	-				22.0	24.0	21.0	0.18	1	.676
General uncertainty	-	-	-				36.0	54.0	27.0	10.55	1	**.001**

Note: n=number; M = mean; SD = standard deviation; df = degrees of freedom; *p* = *p*-value, significance level *p*<.05

[1]dichotomized: burdened (s. Table above) including “somewhat burdensome” and “very burdensome” vs. not burdened including “not at all burdensome” and “a little burdensome”

Burdening aspects

Many of students felt burdened due to the lack of interaction with fellow students. In comparison to medical students, significantly more dental students stated that they were burdened with regard to the exams and the general uncertainty (Table 3).

Binary logistic regression indicated that dental students (OR: 4.0; CI (95%): 1.1 – 14.2) were significantly more likely to experience serious worries regarding the current study situation during COVID-19 than medical students in May 2020. In July 2020 higher distress (OR: 1.8; CI (95%): 1.3 – 2.5) was associated with a higher likelihood for reporting serious worries regarding the current study situation during COVID-19 (Table 4).

Table 4: Binary logistic regression models on the association of study subject, depression and distress with serious worries in dental and medical students during the COVID-19 pandemic.

May 2020	**Odds ratio (OR)**	**95% confidence interval (CI)**	***p***	***effect size*[1]**
Subject of study				
dental	4.0		n.a.	
medical	Reference	1.1 – 14.2	**.031**	.032
Distress (DT)	1.4	0.9 -1.9	.078	
Depression symptoms (PHQ-2)	1.5	0.9 - 2.6	.091	
July 2020				
Distress (DT)	1.8	1.3 – 2.5	**.001**	0.24

[1]According to Cohen's guidelines (1988) we considered f^2= .02 to be a small effect, f^2=.15 as a medium effect, and f^2=.35 as a large effect.

Current concerns and helpful aspects

A total of 52 students (39.4%) provided optional free-text responses regarding the question "What is currently occupying you most in your current study situation?". We identified five categories in a multistage inductive process. The most frequent categories were "difficulties with self-regulated learning and self-motivation", followed by "study-related worries and uncertainty", "lack of feedback from other students and lecturers" and "lack of practical training". Significantly more dental (20.5%) than medical students (4.5%) reported concerns about the lack of practical training (chi^2 = 8.4; df = 1; *p*=.004) (Table 5).

Table 5: Categories, examples and quantified responses by category for the questions "What is currently occupying you most in your current study situation?" in May 2020 (n=132)

What is currently occupying you most?		Whole sample (n=132) mentioned	Dental students (n=44) mentioned	Medical students (n=88) mentioned			
Category and subcategory	**Example**	**%**	**%**	**%**	**Chi²**	**df**	***p***
Difficulties with self-regulated learning (n = 20; 15.2%) • Self-Motivation • Difficulties with new learning environment	"Self-motivation- the exchange with fellow students and lecturers is missing, and therefore one has to motivate oneself every day anew to sit down at home (the library as a room for studying is also missing) and to motivate oneself to nevertheless 'attend' all study courses in time and to catch up on the study-work." "Since I don't have the proper learning environment at home, I found it difficult to learn the very extensive content in an appropriate manner."	15.2	15.9	14.8	0.03	1	.864
Study-related worries and uncertainty (n = 19; 14.4%) • Concerns to perform worse/ to fail • Study-related uncertainty	"Extreme pressure to teach myself the mass of content in a short time through e-learning in order to succeed on the exam." "The uncertainty of if and when face-to-face classes can be held again, and if potentially my study time will be extended due to this pandemic."	14.4	20.5	11.4	1.97	1	.161

Lack of feedback from other students and lecturers (n = 15; 11.4%)	"Due to the online format, the exchange with fellow students and the lecturers is missing. (…)."	11.4	11.4	11.4	0.00	1	1.000
Lack of practical training (n = 13; 9.8%)	"The practical components in dental education are essential and (...) are now being cancelled. (…)"	9.8	20.5	4.5	8.36	1	**.004**
Other (n = 9; 6.8%)	"Lack of available childcare. Learning with (...) children at home is a challenge."	6.8	11.4	4.5	2.15	1	.143

Note: n=number; df = degrees of freedom; *p* = *p*-value, significance level *p*<.05

Furthermore, 53 students (40.2%) completed optional free-text responses to the question "What do you currently experience as particularly helpful?". Again five categories were identified through a multi-step inductive process. The most common categories were "Exchange with other students and lecturers", followed by "flexibility due to online lessons", "self-regulation, -motivation and -structuring", and "balance through sports and leisure". Dental and medical students did not differ significantly in their answers with regard to helpful aspects (Table 6).

Table 6: Categories, examples and quantified responses by category for the questions "What do you currently experience as particularly helpful?" in May 2020 (n=132)

What do you currently experience as particularly helpful?		Whole sample (n=132) mentioned	Dental students (n=44) mentioned	Medical students (n=88) mentioned			
Category	**Example**	**%**	**%**	**%**	**Chi²**	**df**	***p***
Exchange with students and lecturers (n = 18; 13.6%)	"Intensive exchange with fellow students and lecturers."	13.6	15.9	12.5	0.29	1	.591
Flexibility due to online lessons (n = 17; 12.9%)	"The online semester also brings many advantages. You can arrange everything yourself and work at your own pace. This also takes away a lot of stress for me personally (...)"	12.9	15.9	11.4	0.54	1	.462
Structure and self-discipline (n = 13; 9.8%)	"Studying online to regain routine in everyday life."	9.8	11.4	9.1	0.17	1	.680
Balance through sports and leisure (n = 11; 8.3%)	"The fact that I can do my team sports again, that gives me enough variety and distraction "	8.3	11.4	6.8	0.79	1	.373
Other (n = 9; 6.8%)	"Encouragement of friends and family"	6.8	9.1	5.7	0.54	1	.464

Note: n=number; df = degrees of freedom; *p* = *p*-value, significance level *p*<.05

DISCUSSION

This study investigated the mental burden and study situation among undergraduate dental and medical students after the initial stage of the COVID-19 pandemic from May 2020 to July 2020. In line with previous studies conducted before the pandemic dental and medical students reported high levels of distress, anxiety and depression[8, 12, 42]. Compared to the norm population students of both professions reported significantly higher levels of anxiety and depression, consistent with findings of other studies[8, 43]. In light of the COVID-19 pandemic, the presence of additional pandemic specific stressors is likely[22]. A recent study showed that for most students isolation from student social networks is associated with increased anxiety levels[24]. According to our qualitative data, the lack of direct contact with fellow students, which could only take place via online media, affects both student professions negatively. These findings complement a recent empirical study in which undergraduate medical students reported lack of interactions with peers, faculty, and patients in practice as negative aspects of digital teaching[44]. For dental students, the lack of practical training played a major role, as dentists usually take dental courses from the first semester onwards to learn the practical skills from early stage on[45]. In comparison, this issue does not yet affect medical students as much in the early stages of their studies, as the undergraduate medical curriculum in Germany includes fewer practical training during this time[46]. In sum this probably accounts for our findings that reported levels of anxiety and depression are even higher than among students of the same medical school prior to the Corona pandemic[8].

With regard to the study situation, medical and in particular dental students were concerned about their current study situation. This trend continued in the further course of the pandemic. These results corroborate recent findings in a representative sample in Austria with a notable decline in mental health during the pandemic[47].

In line with the findings of Stangvaltaite-Mouhat et al. (2020) female dental students showed more pronounced anxiety symptoms than male dental students in our study[11]. This underlines that mental burden may be higher among female students in general[48]. Recent studies also suggest that women are particular burdened during the COVID-19 pandemic[47, 49, 50, 51, 52]. Furthermore several studies showed that certain age groups, including individuals between 18 and 25 years old - the most common age group in students - suffered more from mental distress[47, 49, 51, 53]. Qiu et al. (2020) suspect social media to be one of the causes[49]. Previous research seems to confirm this hypothesis as younger people tend to receive a large amount of information via social media, which can easily trigger stress[54]. The easy accessibility and constant presence of pandemic information may lead to an increase in the duration of information consumption. This increasing duration reinforces the potential negative influence on mental health[55]. A noteworthy finding is that dental students

reported increased levels of distress, anxiety and more worries in the second survey whereas medical students' scores were slightly lower at the second survey.

There are some limitations of our study. The cross-sectional surveys at two different times do not allow causal statements about longitudinal developments. Another limitation is the univariate nature of the analysis conducted. The univariate model is less comprehensive compared to multivariate models and does not consider the potential influence of other factors. The small sample size limits representativeness. However, due to the high response rates (65-87% in the first and 81-82% in the second survey) one may assume that a majority of the respondents participated in both surveys. Thus, these single-institutional and cross-sectional surveys achieve a high level of comparability and representativeness. Still there was a considerable proportion of students that did not participate in the surveys, which might lead to a volunteer bias[56]. Nonvolunteers may encompass students who suffer from high levels of distress, anxiety and/or depression. Thus some of the parameters reported in the study may be underestimating the true burden.

Furthermore, no comparisons can be made with the situation before the outbreak of the pandemic, among the same population. Nevertheless, the study by Heinen et al. (2017) conducted at the same medical school with the same measures serves as a valid context to frame our findings[8].

Considering the worsened levels of psychological distress among students during the COVID-19 pandemic [57, 58] academic institutions should provide timely services in terms of tailored interventions, which address the specific worries of dental and medical students. Other authors already provided valuable and concrete recommendations how to reduce the impact of COVID-19 on student-athlete mental health [59, 60]. Grubic et al. (2021) proposed a framework to manage student-athlete mental health during the pandemic including "goal setting/motivation" and "support system/social network" as potential positive influencers. These aspects could be addressed by medical schools in the form of mentoring. Mentoring was identified as valuable intervention for undergraduate medical students due to its association with improved emotional well-being of students before the pandemic[61]. During the pandemic a novel near-peer mentoring intervention via social media was reported with promising first results[62]. Thus, the implementation of mentoring at medical schools or the transfer of existing mentoring interventions digital formats might help to reduce the negative impact of the COVID-19 pandemic on dental and medical students. At the same time longitudinal research is needed to monitor the mental health of students during the pandemic and after as well as rigor evaluation of all interventions.

Conclusion

Overall students of medicine and dentistry are particularly affected by high mental distress and burden due to the demanding contents and structure of their studies. It is likely that the concomitant

symptoms of the pandemic have an additional negative impact on the levels of stress, anxiety and depression of the students.

Especially dental students reported higher levels of burden which might be associated with the high practical content early in their studies. The increase in anxiety levels of dental students might be associated with the duration of the restrictions of especially the practical content during the undergraduate study. Against this background, further monitoring of both dental and medical students during the pandemic would be important in order to develop and introduce tailored prevention concepts adapted to the specific study situation.

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Data availability statement: As ethical approval was not obtained to make data sharing possible outside of the listed research team, no additional data are available.

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Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1

Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5

Bias	#9	Describe any efforts to address potential sources of bias	7
Study size	#10	Explain how the study size was arrived at	4
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	6
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	6
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	6
Statistical methods	#12c	Explain how missing data were addressed	4
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	n/a
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	7
Participants	#13b	Give reasons for non-participation at each stage	n/a

Participants	#13c	Consider use of a flow diagram	n/a
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	7-8
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	9; 11
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	n/a
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
Main results	#16b	Report category boundaries when continuous variables were categorized	9
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	#18	Summarise key results with reference to study objectives	17

Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	18
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	18
Generalisability	#21	Discuss the generalisability (external validity) of the study results	18
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18