Factors Contributing to Zoom Fatigue and Its Potential Link to Depression among Dental Students during the COVID-19 Pandemic

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ABSTRACT

The COVID-19 pandemic reshaped education, compelling dental students worldwide to adapt to online learning. This shift led to 'Zoom fatigue,' a mental exhaustion from prolonged virtual classes. This study explored the prevalence and risk factors of Zoom fatigue among dental students in Thailand and its link to depression. An online survey was conducted among 165 preclinical and clinical dental students from a large public university in Thailand. Data on demographics, health behaviours, and validated scales for the Zoom Exhaustion and Fatigue Scale (ZEF) and the Patient Health Questionnaire (PHQ-9) were collected. More than half (63.6%) reported that online learning negatively impacted their lives. Most students (78.8%) spent over an hour per session, averaging 1.6 sessions daily. Zoom fatigue affected 85.4% of students, with 29.7% experiencing mild fatigue, 33.9% moderate, 20% severe, and 1.8% very severe. Major depressive disorder was present in 37% of participants. Significant predictors of Zoom fatigue included female gender, lack of sleep, underlying mental illness, online learning difficulties, and frequent online sessions. A strong association between Zoom fatigue and depression was observed ($p < 0.001$). The study highlights the high prevalence of Zoom fatigue among dental students during the pandemic. Those affected were more prone to depression, emphasising the need for educational interventions to mitigate the psychological impact of online learning on dental students.

Keywords: *Zoom fatigue, Depression, Dental students, COVID-19, Online learning*

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INTRODUCTION

The COVID-19 pandemic has brought significant changes to dental education. Initiated by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), the crisis disrupted daily life and societal functions worldwide (1). To curb its spread, the World Health Organisation (WHO) recommended preventive measures such as social distancing, restrictive regulations, and remote work (2). In the field of education, these measures triggered a paradigm shift, making face-to-face learning impractical and online lectures the norm (3).

Dental institutions worldwide, including those in Thailand, adopted online learning as an alternative to traditional classroom settings during the pandemic. A study of 13 Asian dental schools found that 94.5% conducted educational activities online, with 53.0% of students open to a predominantly online curriculum (4). Similarly, dental schools and programmes in the United States and Europe implemented policies to shift in-person classroom to online platforms, reducing in-person attendance and enforcing social distancing (5, 6). The Association of Dental Education in Europe (ADEE) also reported a significant shift to online learning, especially for non-clinical courses (6).

Data from the study of ADEE (6) highlights the pandemic's widespread impact on European dental education, with 90% of institutions adopting online learning for non-clinical teaching. However, only 11% of undergraduate dental students were involved in non-clinical activities during their clinical education, showing a diverse range of institutional responses to pandemic changes. The study also notes that 90% of respondents believe public health education will increasingly play a role in dental curricula, signaling a consensus on the field's evolving landscape (6). Additionally, global (7–11) and Asian (4, 11) studies support the view that distance learning will continue to be a major trend in dental education.

The shift from classroom to online learning has introduced a new challenge: Zoom fatigue. Extensively studied by researchers at Stanford University (12), this phenomenon is marked by exhaustion and burnout resulting from prolonged virtual meetings. A key theory, known as Nonverbal Overload, attributes Zoom fatigue to factors such as eye strain from prolonged close-up viewing, increased cognitive load to process information during video calls, heightened self-awareness from constantly seeing oneself on screen, and restricted physical movement during online sessions. External factors beyond individual control, such as unstable internet connections, the pressure of responding to questions in real time, and challenging environmental conditions, can further exacerbate the issue. As a result, Zoom fatigue can significantly impact on individuals' overall well-being (12).

As dental education shifts to virtual learning, the psychological impact of online education on dental students remains underexplored. While research has examined Zoom fatigue and its link to mental health issues among medical students (13–16), studies on dental students, particularly in Thailand, are limited. Regarding depression, previous studies report pandemic-era rates of 22.8% to 33.7% in the general population (17, 18), while 37% of dental students experienced depression, with even higher rates in Asian populations (19). Notably, these figures are based on self-reported data rather than clinical diagnoses by mental health professionals. These findings suggest that dental students are particularly vulnerable, with higher depression rates than the general population.

This study aims to address the gap in research by examining the adverse effects of virtual learning on Thai dental students. Building on previous studies (12, 20), we assessed the prevalence of Zoom fatigue, identified associated risk factors, and explored its relationship with depression during the COVID-19 pandemic. Our findings provide actionable insights to

inform educational practices and policies, supporting the well-being of dental students as virtual learning evolves.

METHODS

Study Population and Setting

This cross-sectional online survey was conducted between 18th May 2021, and 20th October 2022. The study targeted dental students aged 18 or older enrolled in the academic year 2022 at Thammasat University. The participants were invited to respond to an anonymous questionnaire via Google Forms.

The study was conducted in compliance with the Declaration of Helsinki and was approved by the Human Research Ethics Committee of Thammasat University with approval number 051/2565; dated 18th May 2022. Signed informed consent was waived by the Ethics Committee due to the online nature of the survey; however, participants were provided with study information on the first page. The anonymity of participants was maintained throughout the study process, ensuring confidentiality and privacy of the data.

The distinction between preclinical and clinical students is as follows: preclinical students (years 1 to 4) engage solely in lecture-based instruction and do not have direct patient contact or attend hospital sessions, while clinical students (years 5 to 6) participate in both lectures and hands-on patient care. During the COVID-19 pandemic, all lectures, seminars, and examinations for both preclinical and clinical dental students were conducted entirely online. This meant a significant increase in video call activities and reduced opportunities for clinical students to perform procedures on patients, while strict screening and safety protocols were implemented to prevent the spread of COVID-19.

Study Protocol and Survey Tools

This study used a three-part questionnaire: (a) demographic data, (b) the Thai version of the PHQ-9, and (c) the Thai version of the ZEF. A convenience sampling method was employed, distributing the questionnaire to a wide audience and collecting responses from individuals who voluntarily participated. The questionnaire was distributed to dental students via social media platforms (Line, Facebook, Instagram), the primary channels for official student announcements. Participants accessed the survey by scanning a QR code linked to the Google Forms, and the survey was promoted multiple times to ensure a wide reach. The survey tool was programmed to validate complete responses before submission.

Demographic Data

The collected general information includes demographic data, academic year, underlying diseases, daily online session frequency and duration, break times during sessions, exercise frequency, sleep problems, and outdoor activity. Most questions were based on self-assessment, with examples provided to clarify terms. Low outdoor activity was defined as less than two hours per week outdoors. Online study problems included technical issues, engagement difficulties, or other challenges reported by students. Sleep problems referred

to difficulties falling or staying asleep or non-restorative sleep, as self-reported. Mental disease referred to professionally diagnosed disorders such as anxiety or depression. Exercise was categorised as "not at all" (no exercise), "sometimes" (less than 1–2 times per week), or "regular" (more than 1–2 times per week).

Zoom Exhaustion and Fatigue Scale

The ZEF (12) Thai version (21, 22) is a 15-item questionnaire that assesses exhaustion and fatigue associated with video conferencing. It includes five categories: general fatigue, visual fatigue, social fatigue, mental fatigue (motivational fatigue), and emotional fatigue. Each item is rated on a 1 to 5 Likert scale. A higher score indicates a higher level of Zoom fatigue (12). The total ZEF score is averaged by dividing by 15, with scores interpreted as 1 = no, 2 = mild, 3 = moderate, 4 = severe, and 5 = extremely severe. The ZEF was translated through a forward-backward process with permission from Fauville et al. (12). The psychometric properties are detailed in Charoenporn et al. (21) and Charoenporn and Charernboon (22). In this study, Zoom fatigue is defined as the fatigue that occurs after video conferencing or studying using any type of online conference application, such as Zoom, Google Meet, Skype, FaceTime, Cloud X, Webinar, Microsoft Teams, or Cisco Webex. We also asked participants about subjective changes in their videoconferencing fatigue since the COVID-19 pandemic, comparing it to pre-pandemic levels, specifically whether it had worsened, improved, or remained the same.

Patient Health Depression Questionnaire

The Thai version (24) of the Patient Health Depression Questionnaire (PHQ-9) (23) is a self-assessment tool with nine questions that measure the severity of depression symptoms over two weeks. Responses are scored from 0 to 3 (0 = none, 1 = some days, 2 = quite often, and 3 = almost every day). The total score ranges from 0 to 27 points, with a cutoff of ≥ 9 indicating depression (24).

Statistical Analysis

The sample size was calculated using a finite population proportion formula, based on a population of 403, a proportion of 0.217 (21), a margin of error of 0.05, an alpha level (α) of 0.05, and a Z-value of 1.959964, resulting in a minimum of 159 participants. Descriptive statistics summarised participant characteristics. A multivariable linear regression analysed factors influencing Zoom fatigue. Pearson correlation assessed the relationship between PHQ-9 scores and Zoom fatigue scores. All statistical analyses were conducted using STATA Version 14.0 (Stata Corp LLC, College Station, TX, USA), with statistical significance set at $p < 0.05$.

RESULTS

Table 1 presents the demographic data of the 165 Thai dental students who participated in the study. About 70.9% were female, and the mean age was 21.6 years. The majority of students were in their first or second year of education (34.6% and 17.0%, respectively). Most of the students had Zoom sessions at least once a week, with 31.5% having at least one session per day. The mean number of Zoom sessions per day was 1.6 (SD = 0.8), with 78.8%

of these sessions lasting at least one hour. Most students (60%) had breaks of 0 to 30 minutes between sessions.

Table 1: Demographic characteristics and possible associated risk factors

Variables (n = 165)	Mean (SD)	N (%)
Gender		
Male		117 (70.9)
Female		
Age	21.6 (3.4)	
Education year		
First year		57 (34.6)
Second year		28 (17.0)
Third year		22 (13.3)
Fourth year		23 (13.9)
Fifth year		16 (9.7)
Sixth year		19 (11.5)
Underlying disease		
No underlying disease		144 (87.3)
Physical disease		15 (9.1)
Mental disease		6 (3.6)
Exercise		
Do not exercise		37 (22.4)
Sometimes		106 (64.2)
Regular		22 (13.3)
Low outdoor activity		139 (84.2)
Problems with online study		105 (63.6)
Sleep problems		78 (47.3)
Zoom session frequency		
< 1 time/month		69 (41.8)
1 to 2 time/week		44 (26.7)
> or = 1 time/day		52 (31.5)
Number of zoom session/day	1.6 (0.8)	
< 1 hour/session		35 (21.2)
≥ 1 hour/session		130 (78.8)
Breaking time between session		
0 to 30 minutes		99 (60.0)
> 30 minutes		66 (40.0)

Table 2 summarises Zoom fatigue levels and subscales. Most participants experienced some degree of Zoom fatigue (29.7% reported mild fatigue, 33.9% moderate fatigue, 20.0% severe fatigue, and 1.8% very severe fatigue). Only 14.6% reported no Zoom fatigue. It was noted that the majority of preclinical students experienced mild or moderate levels of Zoom fatigue, whereas most clinical students experienced moderate levels.

Mean scores for ZEF subscales—general, visual, social, motivational, and emotional fatigue—ranged from 2.2 to 3.0, with social fatigue being the highest (mean = 3.0). The total ZEF score averaged 2.6 (SD = 1.0). Regarding changes since the pandemic, 43% of respondents felt that Zoom fatigue had worsened, 34.6% reported no change, and 22.4% felt that it had improved compared to before the pandemic.

Table 2: ZEF total score and subscale scores

Prevalence of Zoom fatigue	Total (Year 1–6) N = 165 (%)	Preclinic (Year 1–4) N = 130 (%)	Clinic (Year 5–6) N = 35 (%)
No	24 (14.6)	21 (16.2)	3 (8.6)
Mild	49 (29.7)	42 (32.3)	7 (20.0)
Moderate	56 (33.9)	42 (32.3)	14 (40.0)
Severe	33 (20.0)	22 (16.9)	11 (31.4)
Extremely severe	3 (1.8)	3 (2.3)	0 (0.0)
Zoom fatigue subscale	**Mean (SD)**		
General fatigue	2.8 (1.3)		
Visual fatigue	2.7 (1.0)		
Social fatigue	3.0 (1.1)		
Motivational fatigue	2.6 (1.2)		
Emotional fatigue	2.2 (1.0)		
Total ZEF score	2.6 (1.0)		

Table 3 presents the multivariable linear regression analysis of factors influencing total ZEF scores. Higher scores were significantly associated with female gender, mental health issues, sleep problems, difficulties with online study, and frequent Zoom sessions (1–2 times per week or ≥ 1 time per day). Age and education showed no significant correlation. Exercise frequency, outdoor activity and Zoom session duration were also not significant. While break time between sessions had a negative coefficient, the association was not statistically significant.

Table 3: Factors associated with ZEF

Variable	Coefficient	95% confident interval	p-value*
Gender: Female	4.90	0.26, 9.54	0.04
Age: Year	0.17	−0.57, 0.92	0.65
Education year	1.47	−0.02, 2.92	0.06
Underlying disease			
No	ref	ref	ref
Physical disease	4.32	−2.59, 11.23	0.22
Mental disease	10.91	0.39, 21.43	0.04

Table 3: (*Continued*)

Variable	Coefficient	95% confident interval	*p*-value*
Exercise			
No	ref	ref	ref
Sometimes	0.47	−4.47, 5.41	0.85
Regular	0.03	−7.12, 7.17	0.99
Sleep problems	6.46	2.46, 10.47	< 0.01
Low outdoor activity	−0.02	−5.48, 5.44	0.10
Problems with online study	7.03	2.76, 11.29	< 0.01
Zoom session frequency			
≤ 1 time/month	ref	ref	ref
1–2 time/week	5.48	0.50, 10.47	0.03
≥ 1 time/day	6.67	1.33, 12.01	0.02
Number of Zoom session per day: time	2.15	−0.55, 4.86	0.12
Duration of Zoom session:			
< 1 hour/session	ref	ref	ref
≥ 1 hour/session	0.07	−4.76, 4.89	0.98
Breaking time between session:			
0–30 minutes	ref	ref	ref
> 30 minutes	−2.25	−6.38, 1.88	0.28

Note: *Multivariable linear regression analysis; R-squared = 0.3086, Adj R-squared = 0.2390

Table 4 shows the correlations between burnout (measured by the Maslach Burnout Inventory–Student Survey (MBI-SS), depression (measured by the PHQ-9), and Zoom fatigue (measured by the ZEF-T). The correlation coefficient between Zoom fatigue and depression is 0.31 (p < 0.001), indicating a moderate positive association between these two variables. This suggests that individuals experiencing higher levels of Zoom fatigue are also more likely to report symptoms of depression.

Table 4: Association between Zoom fatigue and depression

	Burnout (MBI-SS)	Depression (PHQ-9)	Zoom fatigue (ZEF-T)
Burnout (MBI-SS)	1.00		
Depression (PHQ-9)	0.31 (p = 0.0001)	1.00	
Zoom fatigue (ZEF-T)	0.48 (p < 0.0001)	0.42 (p < 0.0001)	1.00

Note: *The Pearson correlation coefficient

DISCUSSION

This study is the first to examine the prevalence of Zoom fatigue, its contributing factors, and its connection to depression among Thai dental students during the COVID-19 pandemic. Our findings show a high prevalence of Zoom fatigue among dental students, with most students reporting increased fatigue from online learning. Additionally, we observed a strong correlation between Zoom fatigue and depression in this population.

In our study, 85.4% of dental students reported at least mild Zoom fatigue, aligning with a previous study where 83.7% of Thai medical students experienced similar levels (13). However, there is no prior data on Zoom fatigue among dental students for comparison, either before or after the pandemic. Studies suggest that dental students generally have a negative view of remote learning and prefer face-to-face instruction due to issues like poor communication and technical difficulties (25), limited social interaction, and the absence of non-verbal cues, which can lead to demotivation and isolation (26). These factors may contribute to the high prevalence of Zoom fatigue among dental students.

During the pandemic, Thai dental students faced significant challenges adapting to online learning, particularly related to Zoom fatigue. While recorded lectures provided flexibility, unstable internet, unsuitable study environments, and difficulties with practical and technical subjects online led to cognitive overload and increased stress over academic progression and graduation (27). Similar struggles were reported globally. Indian dental students experienced reduced motivation and difficulty understanding complex subjects due to the mental strain of prolonged virtual learning (28). Jordanian students faced barriers in practical training and concerns about clinical competence, partly due to the limitations of hands-on learning in a virtual setting, adding to cognitive fatigue (29). French students faced delays in graduation and heightened stress due to the suspension of in-person sessions (30). Likewise, United States students dealt with anxiety over meeting clinical requirements on time, exacerbated by the challenges of remote learning environments and mental exhaustion from continuous video-based interactions (31).

Our study found a strong correlation between Zoom fatigue and self-reported depression, indicating that dental students experiencing higher levels of Zoom fatigue are more prone to depression ($p < 0.001$). This aligns with research by Elbogen et al. (32) and Montag et al. (33) which also identified a significant link between the two. Similarly, a study of Thai medical students reinforced this connection, emphasising the need to address both conditions simultaneously (13). This relationship is particularly relevant for educators and dental institutions, as symptoms of Zoom fatigue, such as social and motivation fatigue, closely resemble those of depression. Social fatigue, marked by a loss of interest in social activities after videoconferencing, resembles the anhedonia often found in major depression. Motivation fatigue, characterised by reduced drive and energy post-videoconferencing, parallels the low motivation typically seen in depressive states (34–36). Common factors like lack of control during virtual meetings, disrupted daily routines, and increased isolation may further exacerbate both conditions (37). Prolonged videoconferencing can trigger a chronic stress response, contributing to depressive symptoms (38, 39). Additionally, studies have linked Zoom fatigue to psychological distress, lower life satisfaction, and reduced academic well-being, which are factors associated with depression (40, 41).

Our multivariable linear regression analysis revealed a significant correlation between higher total ZEF scores and several factors: being female, having a mental illness, experiencing sleep difficulties, facing challenges with online learning, and participating in Zoom sessions more frequently (at least once or twice a week or daily). These findings

highlight the multifaceted nature of Zoom fatigue, with each factor contributing uniquely to its development. Women were more likely to experience Zoom fatigue, aligning with previous research (32, 35, 41), which suggests that women tend to experience higher levels of mirror anxiety, increased self-awareness, more negative emotions (35), and stronger emotional responses than men (39). Mirror anxiety, in particular, is associated with the social fatigue component of Zoom fatigue (35, 42, 43). Participants with pre-existing mental health conditions were also more prone to Zoom fatigue. Previous studies have shown that individuals with pre-existing medical or psychiatric conditions faced heightened risk of adverse psychosocial outcomes during the COVID-19 pandemic 44–46). The cognitive demands of videoconferencing, which require sustained attention and active participation, can exacerbate symptoms of cognitive overload, leading to greater exhaustion (43, 47). Sleep difficulties were strongly associated with increased fatigue, as poor sleep quality impairs cognitive function, lowers energy levels, and weakens stress resilience (48). Sleep disturbances are bidirectionally related to psychiatric disorders such as depression, anxiety, bipolar disorder, and schizophrenia, making individuals with sleep issues more vulnerable to Zoom fatigue (49). Challenges in online learning, including technical difficulties, low engagement, and difficulty adapting, contribute to cognitive overload and higher ZEF scores (36, 44, 48). Struggling to understand content or maintain focus increases mental effort and exhaustion. The lack of immediate feedback and interaction in virtual settings can heighten stress, isolation, and negative emotions while reducing concentration, motivation, and performance (50). Finally, frequent Zoom use has been consistently associated with higher fatigue levels, as increased videoconferencing sessions correlate with greater exhaustion (12, 13, 26, 42).

Our findings suggest that dental institutions should consider reducing the number of online sessions per week and providing additional support for students, particularly those new to this format. Screening for risk factors such as comorbid mental illnesses or sleep problems is also recommended to help mitigate Zoom fatigue and depression.

Limitations

Several limitations must be acknowledged. First, this is the first national study on Zoom fatigue among dental students, with no prior research available for comparison. Second, the cross-sectional survey design prevents establishing a causal relationship between Zoom fatigue and depression. Future studies should explore this relationship further. Additionally, this design does not allow for assessing changes in psychological states over time during the pandemic.

It is also important to note that the majority of participants were preclinical dental students. Clinical-year students, who typically have greater time constraints and are less active online, may have contributed disproportionately fewer responses. Additionally, since the sample was drawn from a single dental education centre, the findings may not be generalisable. Expanding future research to multiple centres would improve external validity and provide a more comprehensive understanding of Zoom fatigue among dental students.

Zoom fatigue is a relatively new concept, with a limited body of research and a lack of standardised criteria, which complicates prevalence comparisons. Additionally, this study did not distinguish between fatigue from online lectures and interactive meetings. Future research should clarify this distinction to better understand the phenomenon.

CONCLUSION

In conclusion, Zoom fatigue was prevalent among Thai dental students, indicating the negative consequences of online learning among these future dentists. Both instructors and learners should acknowledge Zoom fatigue and its link to depression. Students who are female, have mental health issues, sleep problems, difficulties with online learning, or frequent Zoom sessions should be routinely screened for Zoom fatigue. This study offers valuable insights for educators and policymakers striving to optimise online learning while protecting students' mental health.

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ETHICAL APPROVAL

Ethical approval for this study was obtained from the Human Research Ethics Committee of Thammasat University (Medicine) (Project number: MTU-EC-OO-0-051/65).

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