



Zoom fatigue and integrated anxiety-stress: The mediating roles of mind wandering and boredom proneness

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ABSTRACT

The COVID-19 pandemic had a significant impact on many aspects of daily living, resulting in specific precautions that had to be taken to inhibit the spread of the virus. Due to this, in-person face-to-face education was suspended, and distance education was implemented. Online platforms such as Zoom are frequently used in conjunction with distance education. However, Zoom fatigue has developed as a result of excessive and uncontrolled use. Therefore, the purpose of the present study was to investigate the association between Zoom fatigue and integrated anxiety-stress, the relationship of this association with mind wandering and boredom proneness, and whether this association is mediated by them. The sample comprised 321 adults (48 % females, $M_{age} = 24.89$ years, $SD = 8.70$) in different regions of Türkiye, between the ages of 18 and 66 years, and from different occupational groups. According to the results of serial mediation analyses, Zoom fatigue had a significant direct effect on integrated anxiety-stress. The combination of mind wandering and boredom proneness serially mediated the relationship between Zoom fatigue and integrated anxiety-stress. All results are discussed in the context of the psychological consequences of the COVID-19 pandemic and the relevant literature.

1. Introduction

Millions of individuals have been influenced both physically and psychologically by the COVID-19 pandemic. To inhibit the spread of the virus, many precautions were taken by national governments which changed people's everyday routines and led to substantial changes in behavior and working practices (da Silva Neto et al., 2021; Zhang et al., 2020). One of these changes took place in the education field. Worldwide, face-to-face education was suspended, and all teaching and supervision activities moved online (Giannini & Lewis, 2020). Educational activities were carried out on a variety of online platforms during this process, especially Zoom (Kristóf, 2020; Nguyen, 2020).

The Zoom online platform was one of the most popular online platforms used in the pandemic because of its practical and easy use (Morris, 2020; Nash, 2020). However, because of excessive, unconscious, and uncontrolled use of Zoom, fatigue associated with its use emerged. This consequence has been termed 'Zoom fatigue' (Wiederhold, 2020). The aim of the present study was to explore how Zoom fatigue affects adults'

lives by examining the serial multiple mediating role of mind wandering and boredom proneness in the relationship between Zoom fatigue and integrated anxiety-stress levels.

1.1. Zoom fatigue

Although Zoom fatigue arose during the pandemic, it is actually based on the wider concept of 'digital fatigue' (Quill, 2017). Due to the pandemic, the concept of virtual fatigue has been used more frequently to express how individuals feel because of the excessive (and sometimes uncontrolled) periods of time that individuals now spend on online platforms (Epstein, 2020). Since, Zoom is one of the most frequently used platforms, the concept of 'Zoom fatigue' has been used to describe any type of virtual fatigue irrespective of the whether the online platform used is Zoom.

However, it is important to recognize that virtual fatigue is not solely the result of screen-based interactions. Research highlights that external environmental factors—such as multitasking demands in home

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environments, lack of physical movement, and interruptions from household responsibilities—can exacerbate fatigue experienced during virtual meetings (Fauville et al., 2021; Wiederhold, 2020). In this sense, fatigue emerges not only from the features of the technology itself (e.g., limited nonverbal cues, constant self-view, or screen time), but also from the wider socio-spatial context in which digital interactions take place. These contextual elements can heighten cognitive load and reduce opportunities for psychological detachment, resulting in intensifying feelings of fatigue. The blurring of boundaries between personal and professional spheres, especially when working remotely (occupationally and/or educationally), may play a critical role in the experience of virtual exhaustion (Bennett et al., 2021).

It is possible to trace the psychological roots of Zoom fatigue to cognitive load theory. Cognitive load theory refers to the amount of resources used in the interaction between working memory, which has a limited capacity for processing verbal and visual stimuli, and long-term memory, which is unlimited (McCabe et al., 2023). The prefrontal cortex, which has a working memory capacity of approximately four tasks, experiences cognitive overload when faced with more than four tasks simultaneously. In Zoom meetings, the presence of multiple tasks, stimuli, and technological distractions simultaneously increases cognitive load among individuals (Brennan, 2021). Research has indicated that when multitasking, individuals struggle to maintain attention (Peper et al., 2021), perform worse on memory tasks (Madore et al., 2020), and experience negative impacts on their communication processes (Bailenson, 2021).

The richness of interaction provided by video conferences can cause individuals to feel overwhelmed by the effort required to maintain and monitor numerous non-verbal communication cues, which in turn can negatively impact their social relationships, overall life satisfaction, and wellbeing (Queiroz et al., 2023). Fauville et al. (2023) reported that individuals who frequently used Zoom for long periods with few breaks experienced more Zoom fatigue due to their efforts to maintain non-verbal cues (being watched by others, making eye contact, constantly being exposed to their own image, etc.). This finding supports the theory of non-verbal overload.

Various studies have demonstrated different implications of this fatigue. For instance, it has been stated that individuals can suffer from a variety of health problems such as blurred vision, myogenic pain, and musculoskeletal disorders as a result of spending a lot of time sitting in front of a screen (Brennan, 2021), and that individuals' daily routines and social relationships have been negatively impacted (Degges-White, 2020). In addition, it has been reported that individuals have distraction and concentration problems (Murphy, 2020; Williams, 2020), and that 'mirror anxiety' can occur among individuals who are exposed to their own image for hours (Bailenson, 2021). Moreover, Deniz et al. (2022) reported that Zoom fatigue is associated with general fatigue, visual fatigue, social fatigue, motivational fatigue, and emotional fatigue among individuals.

1.2. Integrated anxiety-stress

Individuals' levels of anxiety and stress significantly increased during the COVID-19 pandemic (Alzueta et al., 2021), which had a significant impact on both mental and physical wellbeing of individuals (Le & Nguyen, 2021; Solomou & Constantinidou, 2020; Wang et al., 2020). Anxiety and stress are also associated with Zoom fatigue, which appears to have become as a serious problem for some individuals during lockdowns, quarantines, and self-isolation periods (Deniz et al., 2022). Moreover, Zoom fatigue causes burnout and stress, increasing mental and cognitive load (Usta-Kara & Ersoy, 2022). Consequently, in this context, Zoom fatigue can be one of the indicators of integrated anxiety-stress.

As one of life's almost inevitable everyday elements, stress confronts most individuals, both positively and negatively (Davis et al., 2000). Moreover, stress can be accompanied with other psychological mood

states such as anxiety (Satici, 2020). Anxiety is a future-focused emotional state linked to anticipating adverse future occurrences (Barlow, 2002). It is appropriate to view anxiety and stress as an integrated concept since they frequently coexist in daily life. Recent research has also demonstrated that individuals can experience problems such as fatigue, stress, and frustration during the online education process (Manea et al., 2020), as well as increased boredom (Massner, 2021). Furthermore, it has been reported that 80 % of university students have difficulty in focusing and maintaining their attention while engaged in online education (Peper et al., 2021). This finding demonstrates that mind wandering can be experienced during online forms of training. Based on the findings of the aforementioned studies, mind wandering and boredom proneness may play a mediating role in the relationship between integrated anxiety-stress and Zoom fatigue.

1.3. Mind wandering

The inability of attention to focus on the current task, preoccupation with cognitions unrelated to the current demands of the external environment, and spontaneous distribution among other internal states are all instances of mind wandering (Schooler et al., 2011; Smallwood & Schooler, 2006), which is the first of the predicted mediating variables in the present study. Mind wandering can be described as individuals being engaged in various inner thoughts, dreams, and emotions that are irrelevant instead of paying attention the task at hand (Smallwood & Schooler, 2006). Although mind wandering may be a useful strategy when faced with a boring task, it has many negative effects on individuals (Mooneyham & Schooler, 2013). Many studies have illustrated the negative impacts of mind wandering such as poor reading comprehension, impairment of sustained attention, and negative mood impact (e.g., Coskun et al., 2022; Figueiredo et al., 2020; Seli et al., 2019). According to these studies, anxiety and stress can emerge among individuals who frequently experience mind wandering. In addition, Poerio et al. (2013) reported that mind wandering is associated with negative mood states such as sadness, and daily worry. In another study, mind wandering was reported to influence individuals negatively (e.g., feeling unhappy, negatively affecting mental health) (Killingsworth & Gilbert, 2010). These two studies demonstrate that integrated anxiety-stress can be associated with mind wandering.

1.4. Boredom proneness

The second mediating variable proposed in the present study's model is boredom proneness. Boredom proneness is generally viewed as the tendency to experience boredom in a wide variety of places and situations and comprises the frequency of experiencing boredom, the intensity of experiencing boredom, and the perception of boredom (Farmer & Sundberg, 1986). Boredom proneness has been reported to have three characteristics: (i) the frequency of experiencing boredom; (ii) the intensity of the boredom when the individual experiences it; and (iii) a global perception of how boring the individual perceives their life to be (Tam et al., 2021). A study by Sommers and Vodanovich (2000) demonstrated that boredom proneness has various effects on physical health (e.g., eating disorders, musculoskeletal, and cardiovascular disease) and mental health (e.g., anxiety, stress, and depression). Several studies have also found that boredom proneness has an impact on individuals' feelings of hope, loneliness, and life satisfaction (e.g., Farmer & Sundberg, 1986; Tam et al., 2021). In addition, boredom proneness has also been associated in other studies to both anxiety and depression (e.g., Geiger et al., 2021; LePera, 2011; Yang et al., 2021). These findings indicate that boredom proneness may be a potential predictor of integrated anxiety-stress.

1.5. The present study

Zoom fatigue, which emerged during the COVID-19 pandemic,

threatens the mental health of individuals. Therefore, it is important to examine how Zoom fatigue affects the lives of individuals and which variables should be focused on to reduce such fatigue. To date, Zoom fatigue has only been investigated in a few studies (e.g., Nesher-Shoshan & Wehrt, 2022; Ratan et al., 2022; Riedl, 2022; Turgut & Okur, 2022). Therefore, based on previous findings, the present study investigated the serial multiple mediation role of mind wandering and boredom proneness in the relationship between Zoom fatigue and integrated anxiety-stress levels among adults.

There are various theoretical foundations for identifying mind wandering as the first mediator and boredom proneness as the second mediator. Previous research has shown that (i) as the frequency of mind wandering increases during task performance boredom also increases (Zanesco et al., 2024), (ii) attention deficits and mind wandering cause boredom (Eastwood et al., 2012), (iii) mind wandering (especially spontaneous mind wandering) leads to boredom proneness (Deng et al., 2022), and (iv) boredom's inhibitory effect on memory is linked to the influence of mind wandering (e.g., Blondé et al., 2022; Martarelli et al., 2021).

These dynamics are especially salient among university students, who were highly affected by remote learning and prolonged screen exposure during the COVID-19 pandemic. Due to academic demands, disrupted routines, and reduced social interaction, students may be particularly vulnerable to digital fatigue and its downstream psychological effects (Lemay et al., 2021). In the present study, university students were chosen as the target population because they experienced a radical shift to online learning during the pandemic and continue to rely heavily on digital platforms for academic and social activities. Understanding how Zoom fatigue impacts this cohort is particularly relevant because their developmental stage, lifestyle, and educational context may uniquely shape their cognitive and emotional responses to virtual interaction.

Based on the aforementioned literature and rationale, a serial mediation model was designed to investigate the serial multiple mediation role of mind wandering and boredom proneness in the relationship between Zoom fatigue and integrated anxiety-stress levels. Therefore, it was hypothesized that (i) Zoom fatigue would positively predict integrated anxiety-stress (H_1), (ii) mind wandering would mediate the relationship between Zoom fatigue and integrated anxiety-stress (H_2), (iii) boredom proneness would mediate the relationship between Zoom fatigue and integrated anxiety-stress (H_3), and (iv) mind wandering and boredom proneness would serially mediate the association between Zoom fatigue and integrated anxiety-stress (H_4).

2. Method

2.1. Participants and procedure

The present cross-sectional study used a convenience sampling method to recruit participants. The sample comprised 321 adults, aged 18–66 years, from various regions of Türkiye, representing a variety of occupational groups, including 154 females (48 %) and 167 males (52 %). The mean age of the sample was 24.89 years ($SD = 8.70$). Of the participants, 246 were students pursuing undergraduate or graduate education (76.64 %), and 75 were individuals with a profession and currently employed (23.36 %). The students were individuals who participated in both in-person and online education and were actively engaged in online events (such as training, seminars, conferences, workshops, etc.). Those who were employed were also individuals who actively participated in online events (such as training, seminars, conferences, workshops, etc.). In other words, all participants used Zoom (or equivalent online platforms) in their daily and academic lives.

Through the use of a web-based form, research data were collected. The online survey link was disseminated to public social media groups via the Turkish authors' social media accounts, including Twitter, Instagram and Facebook. Individuals who received the participant

recruitment link were asked to complete an online questionnaire. Before taking part in the study, all participants provided their informed consent. Participants in the present study were all volunteers and were not paid for their participation. Participants were asked to provide descriptive data about their age, gender, and occupation in addition to the four study variables. This was followed by the psychometric measures. The online form was designed in such a way that participants could withdraw at any time and submit only when all the questions had been answered.

2.2. Ethical considerations

The National Defence University Scientific Research and Ethical Review Board (E-1293783) provided approval for the study. The institutional review board's professional ethics guidelines and the Declaration of Helsinki were both followed at every step of the study procedure.

2.3. Measures

Zoom Exhaustion & Fatigue Scale (ZEFS). The ZEFS was developed by Fauville et al. (2021; Turkish version: Deniz et al. 2022). The scale has a total of 15 items and five sub-dimensions (i.e., general, visual, social, motivational and emotional fatigue). The items (e.g., "I feel tired after joining a video conference") are rated on a five-point scale from 1 (*never*) to 5 (*always*) with scores ranging from 15 to 75. The higher the score, the greater the fatigue. The Cronbach alpha coefficient in the present study was.926. The sub-dimensions' Cronbach alpha coefficients ranged from.808 to.902.

Integrated Anxiety-Stress Scale (IASS). The IASS was developed by Ebadi (2020). The 33 items (e.g., "I'm carrying worrying thoughts") are rated on a five-point scale from 0 (*never*) to 4 (*always*) with scores ranging from 0 to 132. The higher the score, the greater the degree of stress and anxiety. The Cronbach alpha coefficient in the present study was.961.

Mind Wandering Questionnaire (MWQ). The MWQ was developed by Mrazek et al. (2013; Turkish version: Sezgin, 2020). The five items (e.g., "I cannot give my full attention while doing my work") are rated on a six-point scale from 1 (*never*) to 6 (*always*) with scores ranging from 5 to 30. The higher the score, the greater the mind wandering. The Cronbach alpha coefficient in the present study was.827.

Short Boredom Proneness Scale (SBPS). The SBPS was developed by Struk et al. (2015; Turkish version: Güner et al., 2021). The eight items (e.g., "Most of the time I just sit there doing nothing") are rated on a seven-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*) with scores ranging from 8 to 56. The higher the score, the greater the individuals' boredom proneness. The Cronbach alpha coefficient in the present study was.899.

2.4. Data analysis

The analysis carried out in the present study was performed in sequential steps. First, some preliminary analyses were carried out. Outliers at the level of.001 were removed from the study's dataset after controlling for the Mahalanobis distance value (Büyüköztürk, 2016). Then, the variables' means, standard deviations, and skewness-kurtosis values were determined. In addition, the Pearson product-moment correlation coefficients were used to assess the relationships between the study's variables. In order to check for any multicollinearity issues within the variables, VIF and tolerance coefficients were calculated and the results of the analyses showed that there was no multicollinearity problem. Based on the current literature, it was determined that the variables' skewness-kurtosis values were between ± 1 , and the normality criteria were satisfied (Tabachnick & Fidell, 2012). Following the completion of these analyses, a serial mediation model (PROCESS macro, model 6; Hayes, 2018) was constructed with mind wandering as

the first mediator and boredom proneness as the second mediator to evaluate the model suggested in the study. Bootstrapping (Hayes & Preacher, 2014) was used to examine the significance level of indirect effects. Maximum likelihood estimation was utilized for the bootstrapping. In the present study, the analysis was carried out by selecting a 95 % confidence interval, and confidence interval values were calculated using 5000 bootstrap samples. If there is no zero value between the highest and lowest confidence intervals, then the mediation is statistically significant (Hayes, 2018). During the study's data analysis phase, statistical analyses were carried out using IBM's SPSS Statistics 26.

3. Results

3.1. Descriptive statistics and correlation analysis

In Table 1, correlations between study variables and descriptive statistics such means, standard deviations, skewness, and kurtosis are shown. All variables in Table 1 had a statistically significant correlations at levels ranging from $r = .448$ to $r = .813$ ($p < .01$). In addition, the skewness coefficients of all variables ranged between $-.032$ and $.535$ and the kurtosis coefficients ranged between $-.997$ and $-.250$. These results indicated that the normality assumption was satisfied. Following the provision of the assumptions to evaluate the proposed model, serial multiple mediation analysis was carried out in light of these analyses.

3.2. Serial multiple mediation analysis

The mediating role of mind wandering (MW) and boredom proneness (BP) in the relationship between Zoom fatigue (ZF) and integrated anxiety-stress (IAS) was tested by serial multiple mediation analysis. In this analysis, the independent variable has a total of four different effects on the dependent variable, one of which is direct and three of which are indirect. This model allows three different mediation models to be tested together. Results related to serial multiple mediation analysis are shown in Fig. 1.

As can be seen in Fig. 1, Zoom fatigue predicted integrated anxiety-stress positively ($c = .597$, 95 % CI = 1.122, 1.512) supporting H₁. The relationship between Zoom fatigue and integrated anxiety-stress was still significant when mediator variables were included in the model continuously, although the level of significance was decreased ($c' = .166$, 95 % CI = .209, .524). This indicates that the mediating variables, mind wandering and boredom proneness, partially mediated this relationship. These findings indicate that H₂ and H₃ were supported. Moreover, Zoom fatigue predicted mind wandering ($a_1 = .447$, 95 % CI = .120, .189) and boredom proneness positively ($a_2 = .371$, 95 % CI = .274, .450), and mind wandering ($b_1 = .230$, 95 % CI = .998, 1.933) and boredom proneness ($b_2 = .582$, 95 % CI = 1.137, 1.496) positively predicted integrated anxiety-stress. Table 2 shows the indirect effect values from bootstrapping analysis that are statistically significant.

Table 2 demonstrates that the proposed model had three different indirect effects. The first indirect effect showed that Zoom fatigue had a statistically significant effect on integrated anxiety-stress via mind wandering (bootstrap value = .103, 95 % CI = .065, .144). The second indirect effect showed that Zoom fatigue had a statistically significant effect on integrated anxiety-stress via boredom proneness (bootstrap value = .216, 95 % CI = .157, .277). Finally, the relationship between

Zoom fatigue and integrated anxiety-stress showed statistically significant serial multiple mediation of mind wandering and boredom proneness (bootstrap value = .111, 95 % CI = .081, .144). To sum up, 5000 sample bootstraps were used to examine the significance of the mediation relationship between the variables, and the analysis demonstrated that there were no zero values between the upper and lower limits of the 95 % confidence interval. This result suggests that the relationship between Zoom fatigue and integrated anxiety-stress is statistically strong and serially mediated by mind wandering and boredom proneness. This indicates that H₄ was supported.

4. Discussion

Zoom fatigue can affect individuals' mental health by having a negative impact cognitively, spiritually, socially, and physically. In this context, a hypothetical model was tested to investigate the anxiety-stress caused by Zoom fatigue among individuals. In the present study, the relationship between Zoom fatigue and integrated anxiety-stress was investigated by examining the serial mediating roles of mind wandering and boredom proneness. The findings showed that mind wandering and boredom proneness had a serial mediating role in the relationship between Zoom fatigue and integrated anxiety-stress.

The study's initial finding was that Zoom fatigue positively predicted integrated anxiety-stress (supporting H₁). This finding is consistent with those of previous studies reported in the extant literature (e.g., Blandin et al., 2021; Deniz et al., 2022; Mamtani et al., 2022). These previous studies have reported that Zoom fatigue triggers emotional fatigue among individuals and consequently, there is an increase in the level of anxiety. Similarly, the study by Elbogen et al. (2022) indicated that Zoom fatigue causes individuals to feel more anxious, emotionally exhausted, and lonely. It has also been shown that individuals who experience Zoom fatigue with the disruption of their daily life routine experience more anxiety and stress (Salim et al., 2022). Zoom fatigue was found to be associated with symptoms of depression, anxiety, and stress among Indian university students (Phakey et al., 2023). All these findings strongly suggest that one of the predictors of integrated anxiety-stress is Zoom fatigue. Also, in the study conducted by McCabe et al. (2023), it was found that students who were required to multitask and were exposed to multiple stimuli during Zoom classes experienced an increase in cognitive load. Due to this high cognitive load, they reported higher levels of mental fatigue, along with an increase in unproductive burdens such as life stress, fatigue, illness, and negative emotions. Supporting the non-verbal overload theory, Fauville et al. (2023) reported that individuals who frequently used Zoom for long durations with minimal breaks experienced more Zoom fatigue due to efforts to maintain non-verbal cues (e.g., being observed by others, making eye contact, constantly being exposed to their own image). These findings suggest that cognitive load may be one of the underlying factors contributing to the integrated anxiety-stress caused by Zoom fatigue in our current model. While these findings align with the broader literature, the present study extends this knowledge by examining the sequential roles of mind wandering and boredom proneness, offering a more nuanced explanation of how Zoom fatigue translates into anxiety-stress in cognitively taxing digital environments.

The second key finding of the present study was that mind wandering played a mediating role in the relationship between Zoom fatigue and

Table 1
Descriptive statistics and correlations of the variables in the study.

Variable	1	2	3	M	SD	Skewness	Kurtosis
1. Zoom fatigue	–			34.49	11.62	0.535	–0.250
2. Mind wandering	0.448*	–		16.25	4.03	–0.032	–0.265
3. Boredom proneness	0.563*	0.593*	–	26.84	11.34	0.199	–0.997
4. Integrated anxiety-stress	0.597*	0.650*	0.813*	55.83	25.63	0.260	–0.278

Note. * $p < .01$.

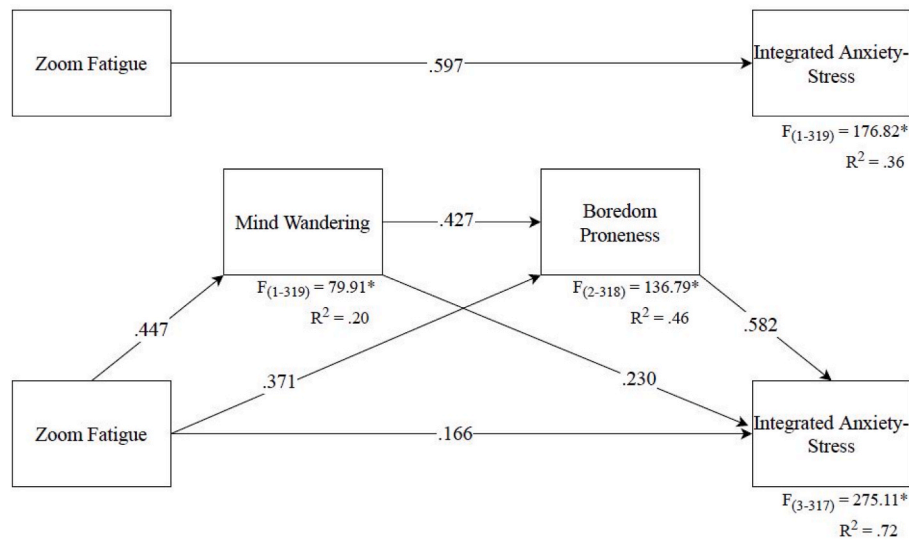


Fig. 1. The result of serial multiple mediational model, * $p < .01$. Values shown are standardized coefficients.

Table 2

The bootstrapping coefficients and confidence intervals regarding the serial multiple mediation analysis.

Effect	Bootstrap Coefficient ^a	Sh _x	Lower Limit ^b	Upper Limit ^b
Total effect	0.597	0.099	1.122	1.512
Direct effect	0.166	0.080	0.209	0.524
Total indirect effect	0.431	0.029	0.374	0.488
Indirect effect (ZF→MW→IAS)	0.103	0.020	0.065	0.144
Indirect effect (ZF→BP→IAS)	0.216	0.030	0.157	0.277
Indirect effect (ZF→MW→BP→IAS)	0.111	0.016	0.081	0.144

ZF: Zoom fatigue, IAS: Integrated anxiety-stress, MW: Mind wandering, BP: Boredom proneness.

^a Standardized coefficient; Based on 5000 bootstrap samples.

^b 95 % confidence intervals.

integrated anxiety-stress (supporting H₂). Individuals who spend excessive (and in some cases uncontrolled) amount of time online platform cannot focus their attention on the current task. Due to Zoom fatigue, it appears that the minds of individuals transition to other emotions, thoughts, dreams, and internal states. It has been reported in the literature that individuals who have been training on an online platform for a long time have difficulty focusing and staying on the task in hand (Peper et al., 2021). Especially because of the pandemic, the fact that individuals think about their health, their families and those around them more often causes them to experience mind wandering when they are online (Bitter & McCrea, 2022). Another study reported that frequent Zoom usage makes individuals more prone to distraction and problems focusing (Williams, 2020). Henley's (2020) research also supports the findings of the present study. Henley's study found that individuals did not feel themselves belonging to a group because they could not communicate effectively on an online platform, and this situation caused individuals to get bored and start doing other things. In sum, individuals appear to engage in more mind wandering when they experience Zoom fatigue. When trying to focus on multiple tasks simultaneously during Zoom meetings, in other words, when cognitive overload occurs, it negatively affects task completion and weakens memory (Brennan, 2021). Individuals who report finding it more difficult to maintain attention while multitasking (Peper et al., 2021) also perform significantly worse on memory tasks (Madore et al., 2020). These findings support the idea, within the framework of cognitive load

theory, that Zoom fatigue leads to mind wandering as indicated in the model. The use of mediation provided a clearer understanding of how and why Zoom fatigue leads to broader psychological strain.

Individuals' anxiety and stress levels rise as a result of mind wandering, which may increase because of Zoom fatigue. In the present study, mind wandering was found to affect integrated anxiety-stress. Similar findings have been reported elsewhere. For instance, Seli et al. (2019) found that individuals who experience mind wandering have higher anxiety and stress. They posited that individuals who cannot concentrate their attention because of mind wandering and disrupt their daily work have greater stress due to not being able to fulfill their occupational duties. Similarly, Figueiredo et al. (2020) reported there was a significant relationship between mind wandering and anxiety. Based on the results of the present study and the aforementioned studies, it can be said that individuals with Zoom fatigue appear to experience more mind wandering and this situation increases integrated anxiety-stress among individuals.

Another key finding of the present study was that the relationship between Zoom fatigue and integrated anxiety-stress was mediated by boredom proneness (supporting H₃). Because of continual online meetings or online training, individuals can become bored. The present study showed that individuals experiencing Zoom fatigue have a high boredom proneness. This finding is supported by previous studies (Peper et al., 2021; Puspandari et al., 2020). These studies reported that individuals experience boredom due to being constantly online in their home environment. Moreover, a study by Ebardo et al. (2021) found there was a significant relationship between Zoom fatigue and boredom. Finally, individuals who experience Zoom fatigue have greater boredom proneness (Massner, 2021). This mediation pathway underscores the psychological strain of prolonged digital engagement by elucidating the specific role of boredom proneness as a psychological conduit through which Zoom fatigue contributes to heightened anxiety and stress.

Increasing boredom proneness due to Zoom fatigue also appears to affect the integrated anxiety-stress level of individuals. When the literature is examined, studies show that boredom proneness is related to anxiety, stress, and depression (e.g., Geiger et al., 2021; Lee & Zelman, 2019). Moreover, Yang et al. (2021) found that individuals who experience boredom more frequently struggle with mental health problems such as anxiety and stress. Based on the findings obtained in the present study and those in the extant literature, it can be stated that Zoom fatigue experienced by individuals appears to increase boredom and individuals may experience integrated anxiety-stress more intensely as a consequence.

Another key finding in the present study was that mind wandering and boredom proneness were serial mediators in the relationship between Zoom fatigue and integrated anxiety-stress (supporting H₄). The effect of Zoom fatigue on mind wandering is also reflected in the boredom proneness of individuals. Various studies have reported a significant relationship between mind wandering and boredom, and it has been emphasized that the inhibitory effect of boredom on memory depends on the effect of mind wandering (e.g., Blondé et al., 2022; Martarelli et al., 2021). Similarly, it has been shown that inattention and mind wandering cause boredom (Eastwood et al., 2012) and that there are significant relationships between these two variables (Bench & Lench, 2013; Danckert et al., 2018; Isacescu et al., 2017). It has also been found that as the frequency of mind wandering increases during task performance, boredom increases (Zanesco et al., 2024), and that mind wandering (especially spontaneous mind wandering) leads to boredom proneness (Deng et al., 2022). These studies have demonstrated that there are significant relationships between boredom and mind wandering. Moreover, as aforementioned, the tendency to boredom also has an effect on the integrated anxiety-stress level of individuals. This finding provides a more comprehensive understanding of the psychological processes through which Zoom fatigue can result in anxiety and stress. In sum, the present study showed that potential indicators of integrated anxiety-stress are Zoom fatigue, mind wandering, and boredom proneness.

4.1. Implications

Besides the physical consequences of the COVID-19 pandemic on individuals, some indirect effects have serious consequences on individuals' mental health. Individuals who spend a lot of time online in video meetings and events start to feel fatigued, which might cause them to become bored and can lead to mind wandering. This finding suggests that individuals can focus on their work more easily and experience less boredom when measures are taken to inhibit Zoom fatigue. At the same time, limiting online use and performing activities that do not involve screen between online meetings is likely to help individuals control their anxiety and stress levels.

As noted in the study conducted by Luebster et al. (2023), implementing various strategies such as intentionally taking breaks from virtual meetings, avoiding back-to-back meetings, scheduling shorter meetings than in-person ones, and reducing screen time can be effective in reducing Zoom fatigue and coping with the stressors of video conferencing. Usta-Kara and Ersoy (2022) asserted that engaging in activities away from digital tools, such as listening to music, reading books, spending time with family, exercising, and spending time in the kitchen, are effective coping methods to reduce the physical and mental fatigue caused by Zoom fatigue. Additionally, regular exercise has been found to be a protective factor against Zoom fatigue (Charoenporn et al., 2024).

It should also be noted that online meetings now appear to have become the 'new normal' even though the pandemic is now over. Therefore, this issue is not something that will necessarily disappear. Although Zoom fatigue appears to have consequences for mental health, the findings of the present study probably have more implications for employers than mental health professionals. If employers put too much emphasis on online meetings, some employees will likely experience Zoom fatigue which may impact workplace productivity. Given that the overuse of online meetings could contribute to stress and anxiety, employers and managers need to keep online video meetings to a minimum and only use them when it is absolutely necessary.

In light of the possibility that educational environments will become hybrid in the future, there are specific implications for both instructors and students. As Salsabila et al. (2021, pp. 288–298) pointed out, to prevent Zoom fatigue, it is recommended that teachers use various learning methods that encourage more creativity in learning and pay closer attention to the impact of Zoom fatigue on students. Students, on

the other hand, are advised to exercise and rest during breaks from online sessions to prevent body aches.

4.2. Limitations and future research

The findings of the present study should be interpreted considering some limitations. The first of these limitations is that the data were collected using self-report scales. Although data were collected on a voluntary basis, such data can be biased by social desirability. The second limitation of the study is that the design was cross-sectional. This means it is not possible to determine any causal links between the variables. Therefore, longitudinal or experimental research designs are needed in future research. In future research, the use of longitudinal research designs are important in order to observe the developmental trajectory of the variables. Additionally, new studies could be designed using experimental methods to establish causal links. In experimental designs aimed at reducing Zoom fatigue, various techniques and activities to reduce individuals' mind wandering, boredom proneness, and ultimately their anxiety and stress levels could be incorporated into the programs. Consequently, the serial mediation model established in the present study could be tested experimentally, allowing for more definitive conclusions regarding causal relationships.

Other limitations include that the sample only included individuals from Türkiye and the sample was relatively small. Moreover, convenience sampling was used to collect the data. Future studies should therefore include larger and more representative samples from both in and outside of the Turkish context although studies from other countries have highlighted similarities in findings. For instance, in a study conducted with Indonesian university students, it was found that those who experienced high levels of Zoom fatigue had higher levels of mental health illness (i.e., stress, anxiety, and depression) (Salim et al., 2022). Similarly, medical students in Thailand with high Zoom fatigue exhibited higher levels of depression (Charoenporn et al., 2024), and Zoom fatigue was found to be associated with symptoms of depression, anxiety, and stress among Indian university students (Phakey et al., 2023). Among working Italians, Zoom fatigue was positively related to sleep problems, emotional exhaustion, and techno-stress factors (Simbula et al., 2024).

These results suggest that Zoom fatigue has similar effects across different countries and cultural groups. However, in a cross-cultural comparative study (USA vs. Germany) conducted by Luebster et al. (2023), it was concluded that Zoom fatigue and video conference stressors vary. The study found that in the US sample, where video conferencing with international and local teams was a part of daily life even before the pandemic, individuals approached integrating communication into virtual contexts with more confidence. In contrast, the German sample had less experience with video conferencing, making it difficult for them to integrate communication into virtual platforms. These findings suggest that the impact of Zoom fatigue on individuals may vary depending on the prevalence of virtual platform use across different cultures. Because the use of virtual platforms for education and work purposes was not widespread in Türkiye before the pandemic, it can be considered normal for Zoom fatigue to induce anxiety and stress among individuals in the Turkish sample. Based on this, future studies that compare different cultural groups may yield more effective results.

5. Conclusions

The present study's findings on the possible link between Zoom fatigue and integrated anxiety-stress showed the serial mediating roles of mind wandering and boredom proneness. Moreover, there is no previous study in the literature in which the four variables examined in the present study have been simultaneously examined. The findings expand on existing research by not only confirming known associations but also showing how Zoom fatigue contributes to psychological distress through interconnected cognitive and emotional mechanisms. It is important to

take precautions to minimize Zoom fatigue, which appeared to have the potential to increase the anxiety-stress experienced by individuals during the COVID-19 pandemic. Therefore, psycho-educational programs need to be developed by fellow researchers to prevent Zoom fatigue. Such programs would benefit individuals in protecting their mental health.

CRediT authorship contribution statement

Tuğba Turgut: Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Sinan Okur:** Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Seydi Ahmet Satıcı:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Mark D. Griffiths:** Writing – review & editing, Supervision.

Data availability

Data will be made available on request.

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