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Digital fatigue in university students as a consequence of online learning during the Covid-19 pandemic

Fatiga digital en estudiantes universitarios como consecuencia de la enseñanza online durante la pandemia Covid-19

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ABSTRACT

The continued use of videoconferencing systems to carry out the teaching-learning process in higher education institutions during the Covid-19 pandemic has had a negative impact on university students' learning, causing digital fatigue. This fatigue mainly affects eyesight, emotional, motivational and social status. The aim of this study was to determine the degree of digital fatigue derived from prolonged exposure to videoconferencing systems among university students. For this purpose, a cross-sectional study design was applied based on the distribution of an online survey. A total of 613 university students aged 18-35 years

(M = 21.54, SD = 3.85) participated in the study. The results obtained revealed that: 1) the degree of prevalence of digital fatigue among university students was medium-high; 2) socio-demographic variables linked to being female, studying in the Arts and Humanities, spending more time in front of an electronic device and connecting via a laptop were indicators of a higher rate of digital fatigue; 3) gender and high hours consumption were predictors of visual fatigue, social fatigue, motivational fatigue and emotional fatigue; 4) visual fatigue, motivational fatigue and emotional fatigue, together with the field of study knowledge, had a significant influence on overall fatigue. Finally, the future lines of research of this work are discussed, highlighting the richness of the data obtained to advance knowledge about digital fatigue and its influence on university learning.

Keywords: digital fatigue, e-learning, higher education, ICT, Covid-19

RESUMEN

El uso continuo de los sistemas de videoconferencia para llevar a cabo el proceso de enseñanza-aprendizaje en las instituciones de educación superior, durante la pandemia derivada de la Covid-19, ha influido negativamente en el aprendizaje de los estudiantes universitarios, provocando fatiga digital. Esta fatiga afecta principalmente a la vista, estado emocional, motivacional y social. El objetivo de este trabajo fue determinar el grado de fatiga digital derivada de la exposición prolongada a sistemas de videoconferencia de los estudiantes universitarios. Para ello, se aplicó un diseño de estudio transversal a partir de la distribución de una encuesta en línea. En el estudio participaron un total de 613 estudiantes universitarios, con edades comprendidas entre los 18 y 35 años (M = 21.54; DT = 3.85). Los resultados obtenidos revelaron que: 1) el grado de prevalencia de la fatiga digital en los estudiantes universitarios fue medio-alto; 2) las variables sociodemográficas vinculadas a ser mujer, cursar estudios de la rama de Artes y Humanidades, pasar más tiempo frente a un dispositivo electrónico y conectarse a través de un ordenador portátil fueron indicadores de una mayor tasa de fatiga digital; 3) el sexo y el consumo elevado de horas fueron variables predictores de la fatiga visual, fatiga social, fatiga motivacional y fatiga emocional; 4) la fatiga visual, fatiga motivacional y fatiga emocional, junto a la rama de conocimiento de los estudios cursados, influyeron de forma significativa en la fatiga general. Finalmente, se discuten las futuras líneas de investigación de este trabajo, destacando la riqueza de los datos obtenidos para avanzar en el conocimiento sobre la fatiga digital y su influencia en el aprendizaje universitario.

Palabras clave: fatiga digital, e-learning, educación superior, TIC, Covid-19

INTRODUCTION

The Covid-19 pandemic made it necessary to digitise all, or a large part, of the teaching-learning process. In Spain, most universities had to adapt to a totally virtual scenario, being traditionally face-to-face universities. This posed a great challenge for both teachers and students. Thus, the impact of digital education due to compulsory confinement during the pandemic caused by Covid-19 had negative effects on the general well-being of university students (Elbogen et al., 2022).

The migration to online education increased the number of hours teachers and students spent in front of screens, either to manage learning processes on digital LMS (Learning Management System) platforms, as well as to attend classes via video calls (Ebner & Greenberg, 2020; Schuler et al., 2021), mainly on Zoom and Google Meet (Walcott-Bedeau, 2022). In this context, students reported increased episodes of stress and anxiety associated with time and dedication to digital activities, and less related to fear or worry about Covid-19 infections (García-González et al., 2022); similarly, increased screen work was associated with sleep disturbances (Zhang et al., 2021).

This situation marked a turning point in educational processes that demand to diagnose and analyse the negative effects on students' academic, psychosocial and socio-demographic development in order to ensure successful academic continuity for all (Williamson et al., 2020).

Several studies derived from distance education during the pandemic argue that online and hybrid models are here to stay (Ashour et al., 2021; Garay et al., 2021), therefore, more research needs to be conducted to understand the phenomenon and avoid further situations of digital fatigue, stress or burnout. In this sense, it is necessary to overcome the obstacles of digital fatigue that prevent students from achieving learning (Mpungose, 2021; Penson et al., 2020), so it is relevant to analyse this phenomenon related to the amount of time invested in videoconferencing, the behaviour according to subjects and disciplinary areas, among other factors. It is necessary to collect information from samples that allow generalisation of the results, as well as to pay special attention to how students experienced and continue to experience it (Ali et al., 2022; Dahabiyeh et al., 2022; Suárez-Guerrero et al., 2022).

In particular, it has been identified that much of the body of research uses general burnout scales to measure the socioemotional impacts of confinement (Mosleh et al., 2022), so there is a need to explore results by applying scales specifically constructed and validated in the context of digital fatigue caused by videoconferencing during the Covid-19 pandemic.

The use of digital technologies for entertainment, work, study and communication often leads to information overload, which can result in digital fatigue syndrome for

users. Generally, fatigue is characterised by a feeling of tiredness, lack of energy or exhaustion (Menting et al., 2018). When it comes to digital fatigue, physical discomfort arises from excessive use of digital devices, such as mobile phones, tablets or the computer; this is also often referred to as digital burnout (Sharma et al., 2021). Studies on digital fatigue are not unique to the pandemic and post-pandemic era. Since before the Covid-19 pandemic, which led to the forced shift to remote work and study, there has been talk of the negative effects of staying connected and the relevance of debating the right to digital disconnection (Zamora, 2019).

The construct of digital fatigue can be theoretically understood under the sub-constructs of visual fatigue, social fatigue, motivational fatigue and emotional fatigue (Fauville et al., 2021). Visual fatigue refers to "significant aggravation when an individual has prolonged use of a digital screen, which may even affect the neural networks of the retina" (Kim et al., 2017, p. 391). According to the framework of Fauville et al. (2021) social fatigue refers to the feeling of wanting to be alone, avoiding involvement in social situations. Motivational fatigue is associated with a lack of motivation to initiate an activity, fear of having to do things. Emotional fatigue is described as "the state of feeling overwhelmed, exhausted and used" (Maslach, 2003, p. 2), e.g. emotionally fearful, irritable, moody. Under this frame of reference, it is necessary to investigate the state of students in the pandemic and post-pandemic era in order to build educational scenarios of integral development for all.

The knowledge generated in recent years has been significant in harnessing digital technologies for learning and caring for the socio-emotional state of students. Studies in the context of the Covid-19 pandemic point to digital fatigue "frequently cited as a barrier to student engagement and efficient learning" (Shahrvini et al., 2021, p. 9). Not to mention the high rates of depression, anxiety and stress, institutions and all types of organisations are required to innovate their methods of consultation, care and follow-up for people experiencing these conditions (Rajkumar, 2020). However, digital fatigue and its psycho-pedagogical and socio-emotional consequences can be addressed by reviewing the quality of online classes, accompanying the student in adapting to the use of digital tools, their emotions and connection between teachers and students (McGaughey et al., 2021). In this sense, it is relevant to implement research tools to identify and reduce the difficulties generated by digital fatigue.

Some predictors of digital video conferencing fatigue may be age or gender. Previous studies reveal that "compared to the male gender, women (...) and those who prefer not to disclose their gender (...) had significantly higher videoconferencing fatigue" (Oducado et al., 2021, p. 317), while in terms of age was not taken into account due to low dispersion. Other similar studies, rather than

reporting indicators and effects by gender, tend to focus on understanding young people's uses of technology today; for example, Durmuş et al. (2022) report that digital fatigue is exacerbated by the fact that, in addition to pursuing an academic life online, young people use digital devices for leisure or entertainment more frequently.

Generally, the body of recent studies has reported similar results in students from various areas of higher education knowledge. For example, medical students have been found to suffer from burnout, and the development of resilience was identified to reduce the risks of digital fatigue (Franco et al., 2022). With nursing students, it is inferred that fatigue is relatively prevalent and may be taking its toll on students (Oducado et al., 2021). Meanwhile, the situation with student teachers found that the non-verbal mechanisms of mirror anxiety, the feeling of being physically trapped, hyper-gaze and cognitive load in the production of non-verbal signals were significantly positively related to Zoom fatigue (Moralista et al., 2022). Similar studies with engineering students share that students reported feeling discouragement, boredom, confusion and worry to a greater extent, and calm and confidence to a lesser extent (Baltà-Salvador et al., 2021). Or even a direct correlation between digital fatigue and anxiety has been claimed (Ngien & Hogan, 2022).

Taking into consideration that the virtuality of teaching has caused students to spend long hours in front of the computer connected to different videoconferences, which has started to generate fatigue, anxiety or worry due to the excessive use of these platforms. The aim of this study was to determine the degree of digital fatigue derived from prolonged exposure to videoconferencing systems in university students. In relation to the general objective, the following questions were posed, which guided and structured the research:

RQ1. What was the degree of digital fatigue of university students during the course of their studies in the context of Covid-19?
RQ2. Were there significant differences in the degree of digital fatigue according to the socio-demographic factors of university students?
RQ3. Which socio-demographic variables (gender, age, field of knowledge, hours, electronic device) significantly influenced digital fatigue among university students?

METHOD

A cross-sectional study design (Hernández et al., 2016) was used, based on the application of a self-administered survey in the population of students at the University of Granada, enrolled during the 2021/2022 academic year.

Participant data were collected at a single point in time using Google Forms and the survey was distributed by email. The sampling was by convenience (Cochran & Díaz, 1980), since the entire student community was invited to participate through the internal lists of dissemination of the University. The final sample was made up of those who decided to participate freely.

Participants and procedure

Participants answered questions related to their socio-demographic data and a standardised scale on digital fatigue. Before answering, information was provided about the purpose of the study, the anonymous treatment of the data and the students had to give their informed consent to answer the questionnaire. In addition, the research was approved by the Ethics Committee of the University of Granada (registration number: 1718/CEIH/2020). The data collection period was from November 2021 to January 2022.

Finally, the sample was defined by 488 women and 125 men (n = 613), aged between 18 and 35 years (M = 21.54; SD = 3.85). Table 1 shows the rest of the socio-demographic data of the participants.

Table 1
Socio-demographic data

	n	%
Gender		
Male	125	20.4
Female	488	79.6
Age		
≤ 20	315	51.4
21-35	298	48.6
Field of knowledge of studies		
Arts and Humanities	70	11.4
Science and Health Sciences	86	14
Social and legal sciences	430	70.2
Engineering and Architecture	27	4.4

	n	%
Hours spent daily on videoconferencing systems		
Less than 3 hours	80	13.1
3-4 hours	117	19.1
4-5 hours	168	27.4
5-6 hours	150	24.4
More than 6 hours	98	16
Device used		
Desktop computer	33	5.4
Laptop	524	85.5
Smartphone or Tablet	56	9.1

Note. Age categorisation has been established based on the World Health Organisation (WHO, 2017): less than or equal to 20 years (adolescents) and 21-35 years (young adult).

Data collection instrument

Digital fatigue was assessed using the Zoom Exhaustion & Fatigue Scale (ZEF) (Fauville et al., 2021). The ZEF scale measured five dimensions of fatigue linked to the use of videoconferencing systems: general (items 1-3), social (items 4-6), emotional (items 7-9), visual (items 10-12) and motivational (items 13-15). Thus, in total it consisted of 15 items with a five-point Likert scale response mode ranging from 1 = "Not at all", 2 = "Slightly", 3 = "Moderately", 4 = "Very" to 5 = "Extremely". The scale scores ranged from 15 to 75 points, with higher scores indicating a higher degree of digital fatigue. The ZEF has been used in several studies, showing good psychometric properties and internal consistency (Oducado et al., 2021; Queiroz et al., 2021). For this study, the reliability calculated with Cronbach's Alpha coefficient was good (α = .914).

Data analysis

The different analyses were carried out with the statistical packages IBM SPSS and IBM SPSS Amos, version 25 (IBM Corp., Armonk, NY). Specifically, the statistical-descriptive values of mean and standard deviation were calculated for each socio-demographic factor with respect to the ZEF scale (RQ1). At the same time, the possible existence of significant differences between the sociodemographic factors was analysed with the T test for independent samples when they were dichotomous (gender) and the ANOVA test when more than two groups were established (age, field of knowledge, hours, device) (RQ2).

On the other hand, to answer RQ3, a structural equation model was developed based on path analysis (PA) (Stage et al., 2010). In the PA, the relationships between exogenous variables (gender, age, field of knowledge, hours, device) and endogenous variables (general fatigue, visual fatigue, social fatigue, motivational fatigue, emotional fatigue) were established. However, it was necessary to calculate the univariate and multivariate normality of the data as a preliminary step for the PA. In this sense, univariate normality values were calculated using the Kolmogorov-Smirnov (K-S) test with Lilliefors correction, taking as a reference that the skewness values were less than three and the kurtosis less than 10 as a criterion of data adequacy (Kline, 2005). Multivariate normality was calculated from Mardia's coefficient (Mardia, 1970).

RESULTS

The mean score of the total sample on the ZEF scale was 49.58 (SD = 12.02), placing them in a medium-high degree of digital fatigue. Specifically, for each socio-demographic factor, the statistical-descriptive data and the possible significant differences between them were collected (Table 2). In relation to the gender variable, the highest mean score was found in the group of women (M = 50.94), with significant differences compared to the group of men (p = < .000). On the other hand, in the age variable, the mean scores were similar and no differences were found between the two groups (p = .939).

On the other hand, the mean score in digital fatigue was conditioned by the field of knowledge of the studies taken by the students, where the highest mean score was obtained by those enrolled in Arts and Humanities degrees (M = 55.11), followed by Social and Legal Sciences (M = 49.57), Sciences and Health Sciences (M = 47.81) and Engineering and Architecture (M = 41.15). In addition, significant differences were found between groups (p = .020). With regard to the number of hours dedicated daily to videoconferencing systems, the number of hours was

a determining factor in the average score, with higher scores being achieved by students who dedicated more hours to videoconferencing. In addition, there were significant differences between the number of hours spent (p = <.000). Finally, there were significant differences in the means achieved according to the device used among the students (p = .049), where the highest mean score was with the use of the laptop (M = 50.02), followed by the smartphone or tablet (M = 48.32) and finally the desktop computer (M = 44.85).

Table 2
Descriptive statistics and group differences

	M	DT	*p*
Gender			
Male	44.29	13.08	<.000
Female	50.94	11.37	
Age			
≤ 20	49.55	11.48	.939
21-35	49.62	12.59	
Field of knowledge of studies			
Arts and Humanities	55.11	10.06	.020
Science and Health Sciences	47.81	12.08	
Social and legal sciences	49.57	11.55	
Engineering and Architecture	41.15	16.97	
Hours spent daily on videoconferencing systems			
Less than 3 hours	43.59	14.17	<.000
3-4 hours	45.67	10.94	
4-5 hours	50.16	10.88	
5-6 hours	51.97	10.74	
More than 6 hours	54.51	11.94	
Device used			
Desktop computer	44.85	14.56	.049
Laptop	50.02	11.78	
Smartphone or Tablet	48.32	12.21	

The normality values showed that the skewness showed an asymmetrically negative curve (skewness = -.383). While the kurtosis took a platykurtic distribution (kurtosis = -.080). Thus, the values of skewness and kurtosis were within appropriate values (< 3 and < 10). However, the K-S test with Lilliefors significance correction showed that the data did not follow a normal distribution, as they were at a p-value below .05 (K-S = .059; gl = 611; p = < .000). Although the univariate normality hypothesis was not fulfilled, multivariate normality was confirmed (Mardia = 5.137), where a value of less than p*(p + 2) was obtained, where p was the number of variables observed (in this case it was 15, corresponding to the total number of items in the scale) (Bollen, 1989).

With regard to the goodness-of-fit indices of the PA model, it should be noted that they were adequate according to the criteria established for each of the indices (Byrne, 2013) (Table 3).

Table 3
Goodness-of-fit measures

Index	Values obtained	Values obtained
χ^2	37.4	
df	19	
χ^2/df	1.96	≤3
GFI	.988	≥.90
RMSEA	.040	<.05
NFI	.971	≥.90
CFI	.985	≥.90
AGFI	.966	≥.90
SRMR	.035	<.08

Note. df = degrees of freedom; GFI = goodness-of-fit index; RMSEA = root mean squared error of approximation; NFI = normalised fit index; CFI = comparative fit index; AGFI = adjusted goodness-of-fit index; SRMR = standarized root mean-square.

With regard to PA, connections were established between socio-demographic factors and the different dimensions of digital fatigue. The relationships formed were gender, age and hours with visual fatigue, social fatigue, motivational fatigue and emotional fatigue. At the same time, visual fatigue, social fatigue, motivational

fatigue and emotional fatigue with general fatigue. And finally, device and field of knowledge with general fatigue (Table 4). Significant values were established between gender with visual fatigue, social fatigue, motivational fatigue (p = < .001) and emotional fatigue (p = .007); age with social fatigue (p = .006); hours with visual fatigue, social fatigue, motivational fatigue and emotional fatigue (p = < .001); visual fatigue, motivational fatigue and emotional fatigue with general fatigue (p = < .001); field of knowledge with general fatigue (p = .010).

Table 4
Final model parameter estimates

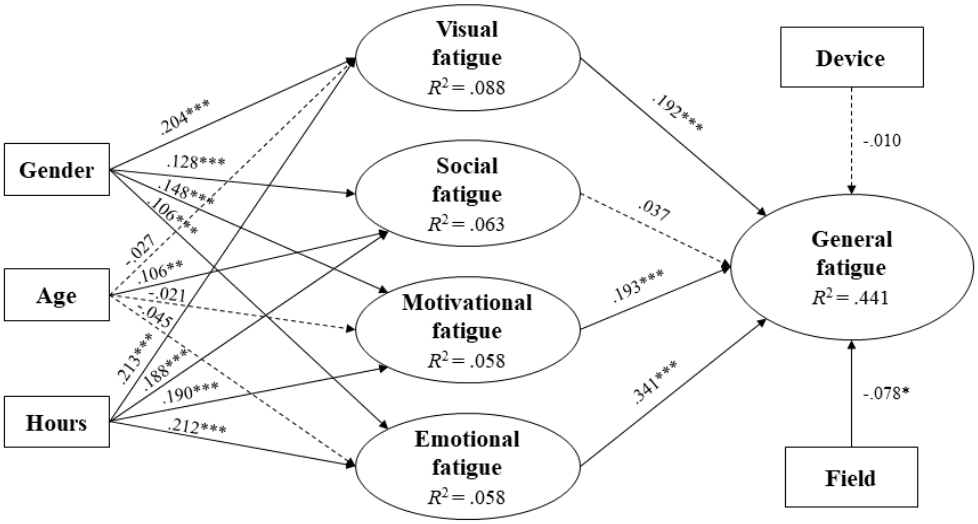
Association between variables	RW	SE	CR	*p*	SRW
Gender → Visual fatigue	1.696	.321	5.278	***	.204
Age → Visual fatigue	-.178	.259	-.687	.492	-.027
Hours → Visual fatigue	.568	.103	5.519	***	.213
Gender → Social fatigue	1.022	.310	3.296	***	.128
Age → Social fatigue	.681	.250	2.722	.006	.106
Hours → Social fatigue	.480	.099	4.838	***	.188
Gender → Motivational fatigue	1.185	.315	3.762	***	.148
Age → Motivational fatigue	-.139	.254	-.546	.585	-.021
Hours → Motivational fatigue	.489	.101	4.850	***	.190
Gender → Emotional fatigue	.844	.313	2.693	.007	.106
Age → Emotional fatigue	-.290	.253	-1.149	.251	-.045
Hours → Emotional fatigue	.541	.100	5.392	***	.212
Visual fatigue → General fatigue	.139	.026	5.431	***	.192
Social fatigue → General fatigue	.028	.028	.988	.323	.037
Motivational fatigue → General fatigue	.144	.030	4.854	***	.193
Emotional fatigue → General fatigue	.257	.033	7.848	***	.341
Device → General fatigue	-.062	.191	-.326	.745	-.010
Field of knowledge → General fatigue	-.166	.064	-2.582	.010	-.078

Note. RW = Regression Weights; SE = Standard Error; CR = Critical Ratio; SRW = Standardised Regression Weights; ***p < .001; n = 613.

The graphical expression of the PA showed the relationship between factors, where the main constructs were visual fatigue, social fatigue, motivational fatigue, emotional fatigue and general fatigue (Figure 1). The significance in the established relationships exemplified the factors that influenced the different dimensions of digital fatigue.

Finally, the percentage of variation for each construct established by the coefficient of determination was 8.8% for visual fatigue (R^2 = .088), 6.3% for social fatigue (R^2 = .063), 5.8% for motivational fatigue (R^2 = .058), 5.8% for emotional fatigue (R^2 = .058) and 44.1% for general fatigue (R^2 = .441).

Figure 1
Path analysis



Note. * Significant at p < .05; **Significant at p < .01; ***Significant at p < .001. Dashed arrow = not significant; n = 613.

DISCUSSION AND CONCLUSIONS

The data collected showed a medium-high degree of digital fatigue in university students due to the continuous use of videoconferencing systems during the pandemic. This may have conditioned students' learning, adding extra difficulties in obtaining a higher grade and adequate development of studies (Ali et al., 2022;

Dahabiyeh et al., 2022; Mpungose, 2021; Penson et al., 2020). Some of the factors to highlight that promote digital fatigue are, among others: the excessive use of the digital screen, the usability of the devices and the fatigue caused by being forced to connect to online classes or having to use the devices to do compulsory tasks. Therefore, the study of the impact of digital fatigue is a highly relevant topic to explain part of the behaviour and conditioning of university students in the Covid-19 pandemic.

As for the significant differences between socio-demographic factors in terms of the degree of digital fatigue, gender was a determining factor showing significant differences, with women having a higher degree of digital fatigue than men. This is in line with previous studies that collected similar data in which women had a higher rate (Oducado et al., 2021). It would therefore be of interest to analyse the cause of such gender differences in further studies.

Another key factor was the field of study, with Arts and Humanities students experiencing a higher degree of digital fatigue. In contrast, previous research has highlighted Health Sciences as the field of knowledge most affected by this phenomenon (Franco et al., 2022; Oducado et al., 2021). Furthermore, depending on the educational institution where the data is collected, the casuistry by field of knowledge may vary depending on the context.

On the other hand, hourly consumption also determined a higher rate of digital fatigue, with students who spent more hours in front of the screen scoring higher. An obvious premise highlighted by authors such as Sharma et al. (2021) was therefore confirmed. In addition, significant differences were also found with respect to the electronic device used, with the laptop in particular standing out as a device associated with a higher prevalence of digital fatigue. It is worth noting, as evidenced by Durmus et al. (2022), that young people use digital devices for leisure and entertainment and not only for academic tasks. As a result, digital fatigue may be exacerbated by the increased number of hours spent in front of an electronic device.

Looking at the impact of socio-demographic variables on digital fatigue, the data showed that gender and number of hours in front of the device were influential factors in visual, social, motivational and emotional fatigue. While age only significantly influenced social fatigue. Furthermore, these three factors were a social determinant of digital fatigue and the socioemotional consequences of wanting to be alone, avoiding involvement in social situations as a consequence of the pandemic (Baltà-Salvador et al., 2021).

Specifically, visual fatigue, motivational fatigue and emotional fatigue were those that had a direct and significant impact on overall fatigue, together with the field of knowledge of the studies taken. These data are in line with the studies by Baltà-Salvador et al. (2021) and Moralista et al. (2022). These four factors determined the

prevalence of digital fatigue in university students, with the negative consequences for their learning that this implies (Rajkumar, 2020; Shahrvini et al., 2021).

It is important to mention that digital fatigue is not unique to the pandemic, but is a problem that has been on the rise in recent years due to the increased use of technology in our daily lives. Although the pandemic has increased the use of video conferencing systems, digital fatigue existed previously and will likely continue to exist in a post-pandemic future.

Finally, the Covid-19 pandemic has led to a significant increase in the use of videoconferencing systems for university education. However, this has led to problems of overexposure to screens and increased mental stress related to information overload and eyestrain. In addition, the lack of face-to-face social interaction and the lack of separation between work and personal space can contribute to feelings of isolation and anxiety. On the other hand, excessive use of videoconferencing has led to difficulties in attention and concentration, which can negatively affect the academic performance of university students. It is important that students, professors and universities take measures to minimise these negative effects, such as setting time limits on videoconferencing and promoting a healthy balance between work and free time.

Specifically, this paper has responded to the objective of determining the degree of digital fatigue derived from prolonged exposure to videoconferencing systems in university students. In addition, a series of research questions of interest to the scientific community have been addressed, where: (RQ1) the degree of digital fatigue of university students has been determined, this average value being 49.58 points; (RQ2) the significant differences between socio-demographic factors have been established according to the degree of digital fatigue, resulting in significant differences between gender (higher score women), field of knowledge (higher score Arts and Humanities), consumption of hours (higher score dedicating more than 6 hours a day to videoconferencing systems, electronic device used (higher score those who used the laptop); (RQ3) the impact of socio-demographic variables on digital fatigue, these being gender and number of hours spent on videoconferencing systems for visual fatigue, social fatigue, motivational fatigue and emotional fatigue; age for social fatigue; visual fatigue, motivational fatigue, emotional fatigue and field of knowledge of studies pursued for general digital fatigue.

The limitations of the study are the limited sample size in some sectors of the population, where in some of them there is a sample imbalance with respect to others. However, in terms of representativeness, the sectors with the largest sample are representative of the total number of students at the University of Granada. In this case, enrolments in the Social and Legal Sciences field are more numerous and the representation of women is higher than that of men, for example in degrees such as those related to Education. Another limitation is that the study was conducted at

a single educational institution, so the results are not necessarily generalisable to other university students at different institutions. In addition, the sample consists of undergraduate students from a single university, aged 18-35 years, which limits the generalisability of the results to other populations, such as undergraduates of other ages or students in secondary education. Nevertheless, this study provides valuable information on digital fatigue in university students during the Covid-19 pandemic, but the aforementioned limitations should be kept in mind when interpreting and generalising the results.

From this study, several lines of research could be proposed to further explore the issue of digital fatigue in university students:

- Conduct longitudinal studies assessing digital fatigue in university students over time, which would determine how digital fatigue evolves and how it is related to the continuous use of videoconferencing systems.
- Conducting similar studies in different educational institutions would allow us to determine whether the results are generalisable to other university students in different contexts and regions.
- To investigate how digital fatigue affects the academic performance of university students and how it relates to the continuous use of videoconferencing systems.
- To find out what strategies are effective in reducing digital fatigue in university students and how they can be implemented in the classroom and at home.

In short, this paper gathers data of interest to the scientific community regarding the prevalence of digital fatigue in university students and the significant and influential factors in it. Aspects that are essential to know in order to alleviate the risk of digital fatigue and solve a problem that has been established in higher education institutions, being common in the case of students due to the necessary use when learning online or in blended learning format.

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