



Game on: A cross-sectional study on gamers' mental health, Game patterns, physical activity, eating and sleeping habits

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ABSTRACT

Introduction and purpose: Problematic gaming patterns have been associated with mental disorders and an unhealthy lifestyle pattern characterized by poor physical activity, nutritional habits, and sleep patterns. Thus, our objective was to characterize highly engaged Portuguese gamers by assessing the prevalence of these health issues and patterns, including Internet Gaming Disorder.

Methods: A sample of 235 gamers (83.3% male) recruited online (through mailing list and social media) participated in online questionnaires to assess sociodemographic and health information, gaming and nutritional habits, physical activity patterns, sleep hygiene, and mental health.

Results: The highly engaged gamers showed a mean playing time of 3.5 h/day ($SD = 2.1$) and 5.5 h/day ($SD = 3.0$) in other screen-related activities. Most of the players reported not consuming snacks while gaming. Physical activity practice was observed in 63.8% of the players. Most of the participants (66.3%) reported poor sleep quality and a “moderately and definitely evening” chronotype (60.4%). Gamers showed low scores of IGD, with only three reported cases, and half of the gamers reporting good psychological well-being. The mean of BSI scores was 1.6 ($SD = 0.6$), close to the cut-off point of 1.7.

Conclusions: Poor sleep quality was observed in Portuguese gamers. Despite this, gamers seem to display a healthy lifestyle consisting of regular physical activity, a healthy diet during gaming time, and an unproblematic gaming behavior, as well as an emotionally healthy profile and state of well-being. Future studies should conduct a more thorough analysis of these variables and further explore possible correlations.

1. Introduction

The video game industry has grown exponentially with the increasing worldwide accessibility to the Internet (Casale, Musico, &

Spada, 2021; Kuss, Griffiths, & Pontes, 2017b). In 2021, it was estimated that more than two billion people played video games, with forecasts indicating that this number may rise to one billion by 2024 (Statista, 2022). The Interactive Software Federation of Europe (ISFE, 2021)

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shared that the average video game player is 31.3 years old, with approximately 53% being male players. Gamers spent, on average, 9.5 h a week playing video games, primarily on their smartphone or tablet (about 60% of the players). Although some gaming information about gamers and gaming activities is available (ISFE, 2021), more information is warranted on their characteristics.

With the rapid increase in gaming, some problematic behaviors have emerged (Rho, Lee, Lee, Cho, Jung & Kim, et al, 2017; Warburton, Parkes, & Sweller, 2022), leading to the inclusion of a psychiatric disorder of gaming addiction in reference manuals related to mental health. Internet Gaming Disorder (IGD) appeared to warrant further research in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; APA, 2013). In addition, the World Health Organization (WHO) added Gaming Disorder (GD) to the 11th edition of the International Classification of Diseases (ICD-11; WHO, 2019). Although recognized by DSM-5 and ICD-11, the diagnosis of IGD remains highly controversial (e.g., Aarseth et al., 2017). Some authors questioned the similarity of these diagnostic criteria with those of disorders associated with substance abuse, arguing that there is little evidence to support the assumption that the nosologic rationale underlying substance abuse disorders may be transferred to the maladaptive gaming patterns some players display (Bean, Nielsen, van Rooij, & Ferguson, 2017). It was also argued that diagnostic criteria do not adequately accommodate the specificities of maladaptive gaming patterns (Bean et al., 2017; Billieux, Flayelle, Rumpf, & Stein, 2019; Kuss, Griffiths, & Pontes, 2017a), Kuss et al., 2017b and do not effectively distinguish between these gaming patterns and healthy use of video games (Billieux et al., 2019; van Rooij et al., 2018).

The gamer population dedicates a substantial part of their time to playing video games (ISFE, 2021), a lot of their relationships are with other gamers (Frederick & Zhang, 2021), and in some cases, it also becomes their career – professional gamers (gamers who play video games for a living; Adamus, 2012). Therefore, it is likely that they may be at greater risk of developing behaviors compatible with Internet Gaming Disorder. However, one of the most discussed criticisms of IGD is that it fails to differentiate gamers with problematic gaming behavior from highly engaged gamers (Bean et al., 2017; Billieux et al., 2019; Kuss et al., 2017a). This type of highly engaged gamers tends to play a substantial number of hours per week or do activities related to video games (like video game live streams) without necessarily experiencing adverse outcomes (Billieux et al., 2019). Exploring the habits and health of this specific population of nonpathological, highly engaged gamers can provide important information about the difference between intensive gaming and problematic gaming, the protective and risk factors of IGD and the development of this disorder in pathological gamers.

On the other hand, associated with these problematic gaming behaviors, other health issues may also be found in this population. Several studies have reported a link between problematic gaming and other mental disorders, such as depression (Ostinelli et al., 2021; Yen, Lin, Chou, Liu, & Ko, 2019), anxiety (González-Bueso et al., 2018), and sleep problems (Alimoradi et al., 2019; Altintas, Karaca, Hullaert, & TASSI, 2019). Furthermore, a higher body mass index and poor eating habits have also been associated with gaming (Chan et al., 2022). For example, a systematic review found that playing video games and vigorous physical activity are negatively associated (Pelletier, Lessard, Piché, Tétreau, & Descarreaux, 2020).

Following the recent admission of IGD and GD (APA, 2013; WHO, 2019), the growth of video game use and the problems related to this activity, it is of the utmost importance to characterize highly engaged video game players, regarding not only gaming behaviors, but also other lifestyle patterns, such as eating and nutritional habits, physical activity habits, sleep patterns, and mental health. The characterization of this population will allow us to better understand both the presence of IGD and mental issues in this community, as well as their sleep patterns (e.g., chronotype and sleep quality), eating habits (specifically during gaming time), daily supplement and beverage intake (i.e., coffee intake and

energy drinks) and physical activity patterns (i.e., time in light, moderate and vigorous physical activity as well as in sedentary time).

With this in mind, the main goal of this study was to explore and describe a sample of Portuguese highly engaged gamers on several characteristics, namely mental health and game patterns, physical activity, eating and nutritional habits, and sleep patterns.

2. Methods

2.1. Participants

Portuguese gamers ($N = 270$), predominantly male (83.3% male, 0.4% non-specified), participated in this study. The inclusion criteria were: i) currently living in Portugal, ii) aged between 18 and 60 years, and iii) currently playing video games for at least 7 h/week in the previous month of this investigation. From the initial sample, 35 participants were excluded since they did not meet the inclusion criteria: age criteria, playing less than 7 h a week, or replying with invalid data (Fig. 1). Therefore, of the initial pool of participants, 235 participants were considered eligible. Participants' recruitment and data collection were performed between September 2021 and May 2022.

2.2. Ethics

This investigation was approved by the Ethics Committee of the Local Institution Review Board (approval number 52/2021) and conformed to all human research standards established by the Declaration of Helsinki (World Medical, 2013). Before participating in any of the study procedures, the purpose and design of the study, the data collection methodologies, and all potential risks and benefits were explained to potential participants. All participants gave their informed consent before enrolling.

2.3. Study design

This study was carried out in an ongoing system with a cross-sectional approach in two phases: an online phase, where participants answered a set of questionnaires related to sociodemographic, mental health, well-being, physical activity, sleeping, gaming, and eating habits (described below); and a laboratory phase, where participants from the online phase were invited to perform body composition assessments, handgrip strength, and 3-day food records to assess nutritional intake (data not shown, will be submitted for publication soon).

2.4. Instruments

2.4.1. Sociodemographic and health information

Participants were asked about discrete sociodemographic characteristics (age, sex, area of residence, date of birth, education, occupation, and marital status). A health anamnesis record was performed regarding the use of chronic medication.

2.4.2. Gaming habits/behaviors and nutritional/supplementation intake

Gaming: Discrete questions related to gaming behavior and habits were performed (type of game, time spent playing, time spent on screen).

Nutrition: Questions were asked about supplement consumption, coffee and energy drink intake throughout the day, and snacking habits during the game.

2.4.3. Physical activity

The International Physical Activity Questionnaire (IPAQ, 2005; Craig et al., 2003) was applied to assess physical activity patterns and showed moderate internal consistency ($\alpha = 0.65$). In the present sample, this instrument showed good internal consistency ($\alpha = 0.77$). From the data obtained, several variables were accounted for to score the domain of

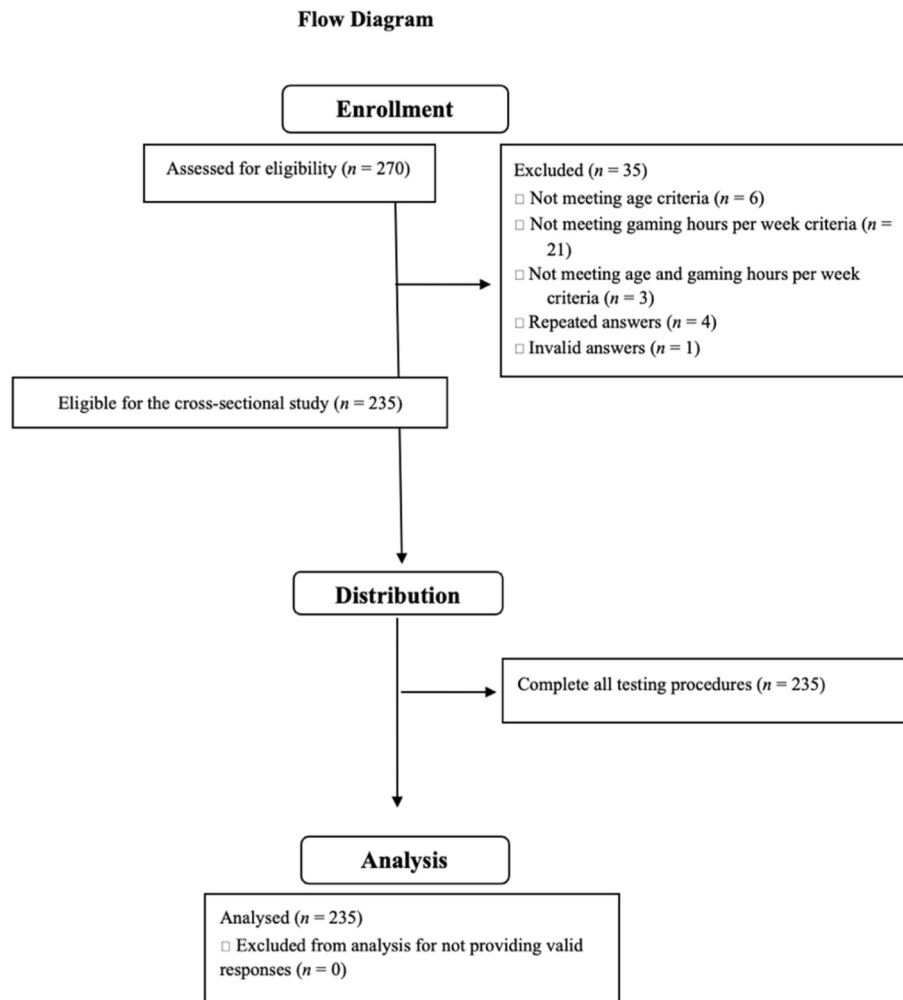


Fig. 1. Flow diagram of the participants.

activity: minutes of physical activity (total), metabolic equivalent of task (MET)/minute/week, time spent in vigorous/moderate/light physical activity and time spent sitting over the week or weekend. The IPAQ short form is a seven-item measure of four domains of activity: vigorous-intensity physical activity, moderate-intensity physical activity, walking, and sitting (IPAQ, 2005). In the present study, physical activity was calculated as the sum of days, hours and minutes of vigorous- and moderate-intensity physical activity (MVPA), presented in minutes (Craig et al., 2003).

2.4.4. Sleep hygiene

Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989): PSQI-PT is a self-rated questionnaire that evaluates sleep quality, sleeping patterns, and disturbances of sleeping patterns over the last month. The test includes a scoring key to calculate the seven components of sleep of the participants: subjective sleep quality; sleep latency; sleep duration; usual sleep efficiency; sleep disturbances; use of sleeping medication, and daytime dysfunction, each of which can range from 0 = “Not during the past month” to 3 = “Three or more times a week”. The sum of the subscores of the components incorporates a global score ranging from 0 to 21. Participants with PSQI scores greater than 5 (0–21 scale) were classified as having poor sleep quality (Buysse et al., 1989). PSQI is validated for the Portuguese population (Del Rio Joao, Becker, de Neves Jesus, & Isabel Santos Martins, 2017), revealing good internal consistency ($\alpha = 0.70$). In the present sample, the PSQI showed an internal consistency of $\alpha = 0.55$.

Morningness-Eveningness Questionnaire (MEQ; Horne & Östberg, 1976):

The chronotype profile was assessed by fulfilling the MEQ-PT, validated in the Portuguese population (Silva et al., 2002), to assess the behavioral manifestation of circadian rhythms showing good internal consistency ($\alpha = 0.86$), as in the sample of this study ($\alpha = 0.80$). The questionnaire has five factors: wake-sleep habits, activation, independence from homeostasis, performance, and diurnal-time awareness. These five factors generate, in total, 16 items that identify the morningness-eveningness chronotype for each participant, with a range of scores from 16 to 86. Higher values indicate more robust morningness profiles, while lower values are related to stronger eveningness profiles. For this study, the following cutoffs were used to classify each chronotype: 16 to 31 score for *definitely evening type*; 31 to 41 for *moderately evening type*; 42 to 58 for *indifferent*; 59 to 69 for *moderately morning type* and 70 to 86 for *definitely morning type* (Silva et al., 2002).

2.4.5. Mental health

Internet Gaming Disorder Scale (Short-Form - IGDS9-SF; Pontes & Griffiths, 2015). This scale was performed to measure the nine diagnostic criteria for IGD present in the DSM-5 (APA, 2013). Each item is rated by participants on a 5-point Likert scale (1 - “Never” to 5 - “Very Often”). The minimum score is 9, and the maximum score is 45, with a cut-off of 32 (Qin et al., 2020); the higher the score obtained, the more severe the symptoms assessed. The original scale (Pontes & Griffiths, 2015) revealed that this instrument has good internal consistency ($\alpha = 0.87$). IGDS9-SF was validated in the Portuguese population (Pontes & Griffiths, 2016) and has also revealed good internal consistency ($\alpha = 0.87$). In the highly engaged Portuguese gamers, internal consistency

was also considered good ($\alpha = 0.81$).

Scales of Psychological Well-being (EBEP-Ryff & Keyes, 1995): This instrument assesses six scales of the theoretical model of psychological well-being: self-acceptance, personal growth, goals in life, positive relationships with others, mastery of the environment, and autonomy. The validated Portuguese short-version (Novo, Duarte-Silva, & Peralta, 1997) consists of 18 items, where each item is rated by participants on a 6-point Likert scale (1 – “Strongly Disagree” to 6 – “Strongly Agree”). The score varies between 18 and 108, with higher scores indicating higher levels of well-being. The instrument revealed an excellent internal consistency ($\alpha = 0.93$). In the present study, EBEP showed good internal consistency ($\alpha = 0.87$).

Brief Symptom Inventory (BSI; Derogatis, 1993): The Portuguese-validated version of BSI (Canavarro, 1999) is constituted of 53 items that evaluate the spectrum of psychopathological symptoms: Somatization ($\alpha = 0.80$), Obsessive-Compulsive behavior ($\alpha = 0.77$), Interpersonal Sensitivity ($\alpha = 0.76$), Depression ($\alpha = 0.73$), Anxiety ($\alpha = 0.77$), Hostility ($\alpha = 0.76$), Phobic Anxiety ($\alpha = 0.62$), Paranoid Ideation ($\alpha = 0.72$), and Psychoticism ($\alpha = 0.62$). In this sample, the alpha for each spectrum of psychopathological symptom was: Somatization ($\alpha = 0.84$), Obsessive-Compulsive behavior ($\alpha = 0.82$), Interpersonal Sensitivity ($\alpha = 0.82$), Depression ($\alpha = 0.91$), Anxiety ($\alpha = 0.85$), Hostility ($\alpha = 0.79$), Phobic Anxiety ($\alpha = 0.81$), Paranoid Ideation ($\alpha = 0.79$), and Psychoticism ($\alpha = 0.76$). Each item is rated by participants on a 5-point Likert scale (0 – “Not at all” to 4 – “Extremely”). In order to obtain a global mental health indicator, the PSI (Psychological Symptoms Index), which is calculated by dividing the sum of all items by the Positive Symptoms Total (Canavarro, 2007). The PSI cut-off point is 1.7, with lower scores indicating high levels of psychological well-being (Canavarro, 2007).

2.5. Procedure

The questionnaire was composed of sociodemographic data, game and physical activity patterns, nutritional and sleep habits, mental performance behaviors, and well being through a unique moment of evaluation of their choice (no schedule restriction). Data collection was implemented through a web-based platform Google Forms (www.google.com/forms), with information about the study, its methodologies, and any potential risks and benefits.

The study was spread through an institutional email from the university where the research was conducted using mailing lists (from universities), mailing lists from the Portuguese Federation of Esports (FPESPORTS), personal contacts, through posts on social media platforms (inviting participants to participate in an internet-based survey on gaming habits). Data collection took place from September 2021 to April 2022.

2.6. Statistical analysis

IBM SPSS Statistics version 25.0, 2012 (IBM, Chicago, Illinois, USA) was used to analyze the data. The Kolmogorov-Smirnov test was applied in order to verify the normality of the variables. Basic frequency and descriptive statistics were run to characterize study participants, including mean and standard deviation, median and interquartile range, as well as minimum and maximum values.

3. Results

3.1. Sociodemographic and health information

The final sample comprised 235 players, of which 85.1% ($n = 200$) were men and 0.4% ($n = 1$) were not specified. The players were between 18 and 56 years old, with the range of 19–22 years representing 42.5% ($n = 120$) of the studied population. Almost half of the players (49.8%, $n = 117$) were from the central region of the country, which

included the capital Lisbon, and 32.3% ($n = 76$) were from the north region of the country. Regarding the professional occupation, 40% ($n = 94$) of the players were students, 39.1% ($n = 92$) were employed, 11.1% ($n = 26$) were both students and employed, and less than 10% ($n = 23$) were unemployed. Regarding the academic degrees, 6% ($n = 14$) of the players finished 9th grade, 37.9% ($n = 89$) had high school degrees, 40% ($n = 94$) had bachelor's degrees, 12.8% ($n = 34$) master's degrees, while 1.7% ($n = 4$) hold a Ph.D. The players were mainly single (83.4%, $n = 196$), with 14.9% ($n = 35$) being married and 1.7% ($n = 4$) being divorced.

Regarding health concerns and identified problems, 86% ($n = 202$) of the players reported not taking any medication, while the remainder 14% ($n = 33$) reported chronic medication use.

4. Gaming and nutrition: habits, behaviors, and patterns

Amateur players represent 81.3% ($n = 191$) of the sample. In comparison, 18.7% ($n = 44$) were semiprofessionals (gamers who are paid to play video games, but not enough to only play for a living) or professionals (gamers who play for a living). The most played games included FIFA (12.7%), Counter-Strike (11.5%), and League of Legends (11%), followed by Call of Duty (6.9%), Valorant (5.1%), Rocket League (4.2%), GTA (3.7%), and Fortnite (3.4%).

Fig. 2 and Table 1 represent the screen time patterns, considering the effective gaming time and the time of exposure to the screen with respect to other tasks that were not related to gaming, school or work, as well as the nutritional habits throughout the day and specifically during gaming time.

In terms of nutritional habits, 29.8% of the sample ($n = 70$) reported consuming dietary supplements. For more detailed information, please refer to Fig. 2.

Note. *BCAAs = branched chain amino acids.

In addition, players were asked about their daily intake of coffee and energy drinks, as well as their food intake during gaming. 60.4% of the players reported drinking coffee, ranging between 1 and 4 or more cups of coffee daily (Table 1 and Fig. 3), and most of the players were drinking coffee without sugar (59.2%).

When effective gaming time was further analyzed, players were asked about their snacking habits during the gaming activity. The mean consumption (day/month) during playing time is shown in Table 2. Other reported foods were water (34% of players), cookies and crackers (12.9%), fruit (6.8%), or others (displaying less than 5% each).

5. Physical activity: habits, behaviors, and patterns

Gamers were asked about their physical activity habits according to the IPAQ. Most players reported performing physical activity (63.8%), with the main sports and activities being team sports (soccer, futsal, handball, basketball, volleyball and paddle – 39%), resistance exercise training (28%), individual sports (such as running, cycling, athletics and swimming – 22%) and combat sports (6%). The patterns of physical activity are displayed in Table 3.

6. Sleep: habits, behaviors, and patterns

Table 4 and Fig. 4 present the results of sleep patterns on sleep quality and chronotype.

6.1. Mental health: habits, behaviors, and patterns

Regarding gaming disorder, only 1.28% ($n = 3$) were equal to or greater than the cut-off point. The average score for IGDS9-SF was 16.5 ($SD = 6.1$; lower than the cut-off point of 32) and ranged from 9 to 36. Taking into account well-being, in the EBEP questionnaire, the mean score was 77.9 ($SD = 14.8$), ranging from 38 to 107, with higher scores indicating higher levels of well-being. Lastly, with respect to BSI, the

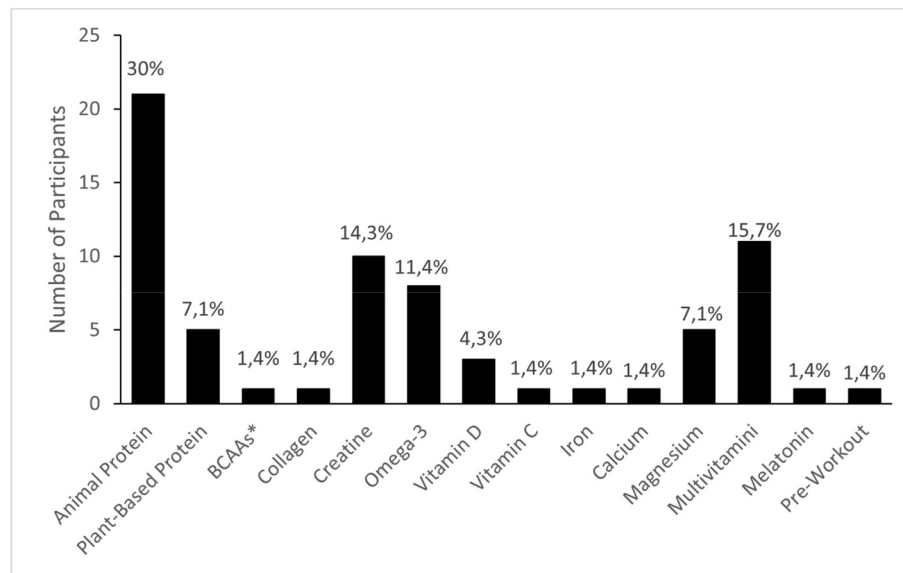


Fig. 2. Dietary supplements use by the players.

Table 1
Characteristic data of players on nutritional habits and gaming patterns.

	Mean (SD)	Median (IQ)	%	N
Playing time:	3.5 (2.1)	3.0 (2.5)		
0–4 h/day			74.9	176
4–8 h/day			21.7	51
8–12 h/day			3.4	8
Daily additional screen time:	5.5 (3.0)	5.0 (3.5)		
0–2 h			19.6	46
3–5 h			35.7	84
>5 h			44.7	105
Coffee intake:	2.1 (1.0)	2.0 (2.0)		
1 per day			33.8	48
2 per day			33.8	48
3 per day			23.2	33
≥4 per day			9.2	13

Note. SD = standard deviation; IQ = interquartile range; % = percentage.

average PSI score was 1.6 ($SD = 0.6$), close to the cutoff point of 1.7, and ranged from 0 to 4. Most players (62.1%; $n = 146$) displayed a healthy profile, with the remainder (37.9%, $n = 89$) displaying an emotionally disturbed profile with respect to psychological well-being.

7. Discussion

This study aimed to explore the individual characteristics of video game players with respect to screen time, nutritional habits while playing, sleep patterns and habits, physical activity and mental health. The results showed that most players spend between 0 and 4 h per day playing video games. These results seem to be consistent with previous studies that reported that highly engaged gamers tend to play between 7 h per week (Forrest, King, & Delfabbro, 2017) and 20 h per week (for example, Billieux et al., 2019). However, more than 5 h daily was spent in additional activities using the computer, meaning that players spend most of their screen time on activities other than video games or related to work/school. This may reflect the fact that this study was conducted during the final months of the COVID-19 pandemic restrictions (in Portugal), which according to some studies, aggravated the time spent using digital devices (Pandya & Lodha, 2021). However, the highly engaged gamers who participated in this study presented a healthy pattern of gaming, with only three cases of IGD reported using this questionnaire (score for gaming addition >32; Qin et al., 2020), which are not significant when considering the total sample. Additionally, most

of our sample reported playing games (FIFA, Counter-Strike, League of Legends, and Call of Duty) on a console and on the computer more than on other platforms, such as mobile. Compared to the ISFE's annual report on video game usage (ISFE, 2021), 54% of gamers play on consoles and 52% play on computers, but 63% play on mobile devices.

Further, by analyzing the well-being status according to the EBEP questionnaire, half of the sample showed poor psychological well-being. These results are not in line with previous research, possibly because most of the time spent on screen time was not related to gaming activities. However, these results suggest that more research is needed with highly engaged Portuguese gamers on gaming and psychological well-being to understand the association between these variables. Despite the fact that most of the players reported BSI scores that were not higher than the cutoff point, the mean global score of this instrument was borderline. Psychological problems have been known to be associated with video games, such as depression (Ostinelli et al., 2021), anxiety (Percy, McEvoy, & Roberts, 2017), and impaired psychosocial well-being (Teng et al., 2020). Furthermore, it should be noted that the COVID-19 pandemic has been associated with mental health problems, such as high levels of stress and symptoms of depression (Gloster et al., 2020), so this may also explain the results regarding BSI and EBEP.

Taking into account nutritional behavior during gaming, the results showed that most highly engaged gamers did not consume ultra-processed snacks (like gummies, lollipops, chewing gums, or other types of fast food) during a gaming session. Most of this population did not consume energy drinks while playing video games. These findings are in stark contrast with the current body of literature; for example, a recent systematic review analysis reported that video games were associated with unhealthy nutritional habits, leading to a higher consumption of snacks, sweets and fast food (Avci, Bayraktar, Kilinçarslan, Bayraktar, & Zorba, 2022). Several other studies reported an association between these variables (Cha et al., 2018; Delfino et al., 2020; Sampasa-Kanyinga, Chaput, & Hamilton, 2015).

Furthermore, some research has also associated these unhealthy habits with players who spend three or more hours playing video games (Puolitaival et al., 2020). Thus, this atypical nutritional behavior of Portuguese players while playing may be explained by their short video gaming sessions, since participants tend to spend less than 4 h per day video gaming, possibly due to time spent in a non-consecutive way. The healthier eating habits of our sample during gaming time may also be explained by the participation in physical activity reported by the participants. Most gamers stated that they were regularly involved in some

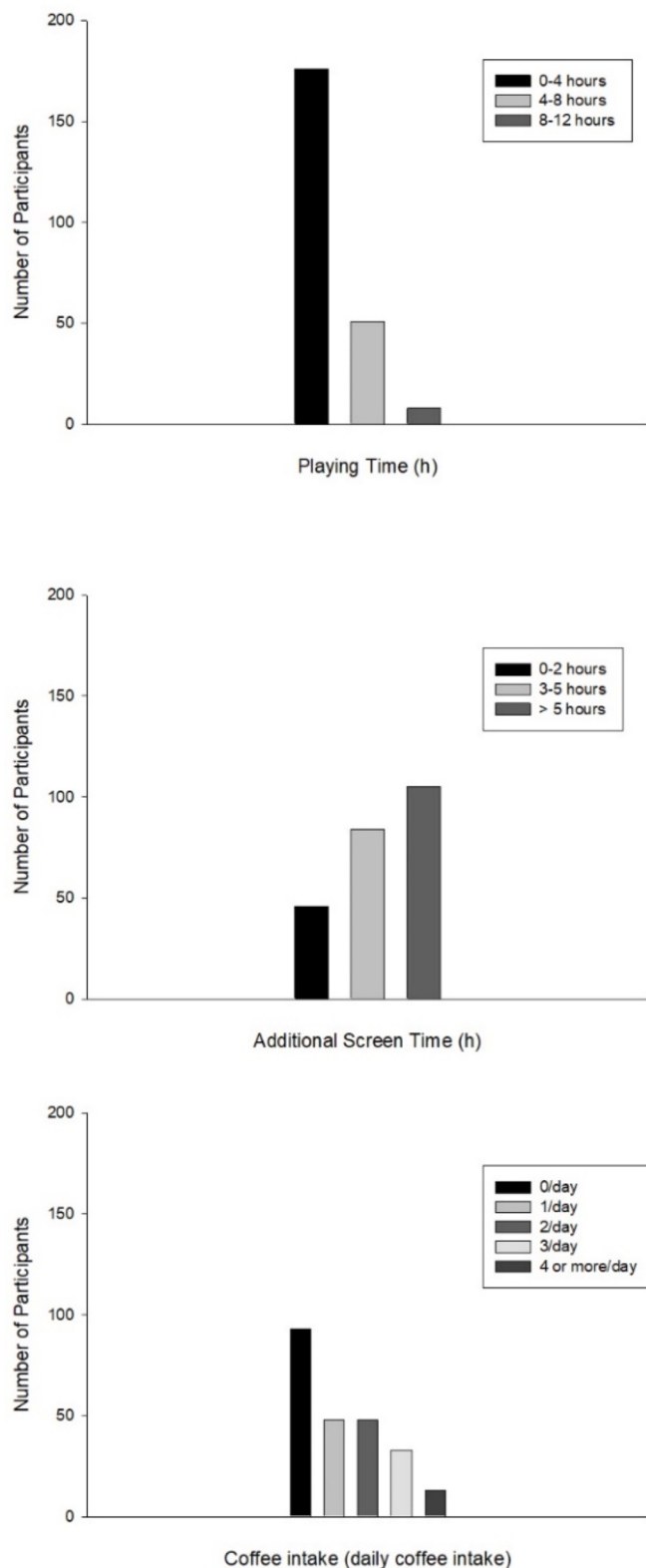


Fig. 3. Gaming patterns and nutritional habits of players (Daily playing time, additional screen time, and daily coffee intake).

type of sport (e.g., team sports, individual sports, combat sports, endurance training) despite the time spent gaming. The literature on physical activity and gaming shows contradictory findings, but suggests a negative association between these variables (Pelletier et al., 2020). Therefore, more research is recommended to understand a possible

causal effect of displaying higher levels of physical activity and a healthier diet while playing on mental health outcomes (either addiction to video games or other mental disorders).

Although highly engaged Portuguese gamers maintain an active lifestyle, our results showed that most of the participants have poor sleep quality. Sleep hygiene, including all sleep-related variables such as quality, time, and latency, among others, have been suggested to be related to several factors that may work both synergistically and individually, that is, choosing gaming over sleep, screen light exposure, mental health issues, food consumption, and physical activity participation. Considering these possible confounding variables, according to the literature, lack of a good sleep pattern, quality, and time may be related to the prioritization of gaming over sleep by shortening sleep hours (Wong et al., 2020). In addition, exposure to screen light in the evening and at night can be linked to disruptions in circadian rhythm by affecting the circadian phase of melatonin levels, consequently leading to poor sleep quality (Tähkämö, Partonen, & Pesonen, 2019). This is particularly important regarding these Portuguese highly engaged gamers since our results show that they spend a considerable number of hours in front of a computer screen (either playing or in other activities).

Another possible explanation for the decrease in sleep quality is mental health issues associated with gaming. Although our sample of players did not show an emotionally disturbed profile according to the applied questionnaires, the mean of the BSI global score was close to the cutoff value, and it is well known that several mental disorders (such as depression and anxiety) can influence sleep duration and sleep quality. For example, Geoffroy et al. (2018) found that in a sample of 3573 subjects diagnosed with a major depressive episode, 3299 (92.3%) had sleep problems (85.2% had insomnia and 47.5% hypersomnia). Likewise, a recent meta-analysis by Cox & Olatunji. (2020) reported that anxiety-related disorders were associated with increased sleep disturbances, difficulty staying asleep, waking up more often, and decreased sleep duration. To understand this possible association, further research is advised on this population.

In addition, to the factors mentioned above, it is well known that nutritional habits also affect sleep quality (St-Onge, Mikic, & Pietrolungo, 2016). Although the participants in this study have a healthy diet during game time, it is unknown what their food consumption is like and what their patterns are outside of this time window. As stated, many processes are involved in sleep regulation, with nutrition being one of the factors involved. However, the link between food and sleep is complex, with ingesting certain nutrients (i.e., tryptophan, phytonutrients), indicating a strong link between diet and sleep (Binks, E Vincent, Gupta, Irwin, & Khalesi, 2020). In a recent review, Binks et al. (2020) focused on sleep-promoting foods and the effects of diet on sleep in otherwise healthy adults. The authors observed that the consumption of certain nutrients (e.g., tryptophan), food items (e.g., cherries) and dietary supplements (e.g., zinc), and that manipulating some nutritional components (i.e., macronutrients and energy composition) can influence sleep outcomes by disrupting or improving sleep. However, these effects seem to vary depending on several factors (e.g., the type of food/supplement, magnitude of dietary manipulation). For example, acute reduction in tryptophan appears to affect serotonin synthesis and reduce latency at REM sleep onset in normal sleepers. Another factor that could influence sleep is the amount of “whole food” consumption, although evidence is scarce at this point (Binks et al., 2020).

Chrononutrition, or the timing of food intake, could also influence sleep (Oda, 2015). Eating at a time that contradicts our circadian rhythms, such as nocturnal eating (a pattern frequently described among video game players), can entrain rhythms in peripheral tissues, having several health consequences, namely metabolic conditions; on the other hand, time-restricted feeding (i.e., shortening the feeding window during the day) or regular meal timing (in particular, breakfast) can entrain circadian clocks, preventing the development of metabolic conditions (Scheer, Hilton, Mantzoros, & Shea, 2009). In addition to chrononutrition, consuming certain nutrients (e.g., caffeine) and melatonin

Table 2
Snacking habits during playing time.

			Consumption (N)						
	Mean (SD) (days/ month)	Median (IQ)	Do not consume	<1 day/ month	1–3 days/ month	1 day/ week	2–3 days/ week	4–5 days/ week	6–7 days/ week
Snack and beverage intake during gaming time:									
Alcoholic drinks	0.7 (1.6)	1.0 (1.0)	174	23	17	14	7	0	0
Soda	2.3 (4.5)	1.0 (2.0)	131	26	30	13	22	12	1
Energy drinks	0.9 (2.6)	1.0 (1.0)	186	15	12	9	10	3	0
Gummies	1.3 (3.5)	1.0 (1.0)	155	40	19	9	6	5	1
Lollipops	0.2 (1.1)	0.5 (1.0)	150	45	20	8	5	6	1
chewing gum	2.0 (4.1)	1.0 (2.0)	140	21	29	19	16	9	1
Chocolate	2.0 (3.5)	2.0 (2.0)	104	45	42	22	16	5	1
Fast food (e.g. pizza, burgers, chips, ...)	1.9 (3.6)	2.0 (2.0)	106	45	47	19	11	6	1

Note. SD = standard deviation; IQ = interquartile range.

Table 3
Time spent in several intensities of physical activity according to the International Physical Activity Questionnaire (IPAQ).

	Mean (SD)	Median (IQ)
Walking (minutes/week)	298.2 (435.9)	180.0 (205.0)
Moderate (minutes/week)	250.8 (436.0)	90.0 (275.0)
Vigorous (minutes/week)	230.1 (411.6)	90.0 (300.0)
Sitting (minutes/week)	420.3 (195.5)	360.0 (180.0)
PAL*	2.4 (0.7)	3.0 (1.0)

Note. SD = standard deviation; IQ = interquartile range; PAL = level of physical activity.

*PAL is 1 as low, 2 as moderate, and 3 as high physical activity level.

Table 4
Sleep scores according to the Pittsburgh Sleep Quality Index (PSQI) and the Morningness-Eveningness Questionnaire (MEQ).

	Mean (SD)	Median (IQ)	Minimum	Maximum	%	N
PSQI	5.7 (2.5)	5.0 (3.0)	1	15		
Good Sleep Quality					33.7	79
Poor Sleep Quality					66.3	156
MEQ	41.1 (9.0)	41.0 (13.0)	21	67		
Definitely Morning					1.7	4
Moderately Morning					7.2	17
Indifferent					30.6	72
Moderately Evening					45.1	106
Definitely Evening					15.3	36

Note. SD = standard deviation; IQ = interquartile range; % = percentage.

supplements may elicit phase shift responses in the sleep/wake cycle, so timing of intake of these specific compounds is of primary importance. Caffeine intake has particular interest, since highly engaged Portuguese gamers tend to consume between one and four cups of espresso coffee daily, which is a considerable amount of caffeine per day.

Despite these encouraging results, some limitations should be addressed regarding our study. First, the investigation began in the last months of the COVID-19 pandemic (when the restrictions were already lifted), which could have influenced the results due to a drastic change in daily habits, routines, and mandatory confinement. An additional limitation should be addressed since this is an exploratory study, and some of the information could have been not correctly collected, such as nutritional information during the day or snacking habits for games.

This study also has a nonprobabilistic sample composed of highly engaged gamers. This specific type of gamers is enthusiastic about video games, and in the case of this study, they were members of an esports federation and/or engaged in video games at least 7 h a week. Therefore, the sample size was expected to not be very large. For instance, in a study by André, Broman, Håkansson, and Claesdotter-Knutsson (2020), the total sample of gamers was 2075 participants with only 94 (4.53%) being highly engaged gamers. Another example, from Lehenbauer-Baum & Fohringer (2015), in a total sample of 577 gamers, only 163 (28.25%) participants were highly engaged gamers. Nevertheless, our results cannot be generalized to all types of gamers, they only describe Portuguese highly engaged gamers.

Lastly, it is important to mention the low internal consistency of PSQI, as it affects the validity of our findings on the quality of sleep of the sample. Other studies also reported this problem, for example Roche et al. (2022) revealed an internal consistency of 0.42 when analyzing the total sample and an alpha of 0.46 and 0.38 when analyzing subgroups of participants. Another study by Pilz, Keller, Lenssen, and Roenneberg (2018), which compared the three different versions of the PSQI (usual, work, and work-free) reported an internal consistency of 0.62 for the “usual” PSQI. Given the limitations of the PSQI scale, it may be beneficial to explore alternative measures or instruments that have better psychometric properties. Replication studies using different instruments can help determine whether the findings hold across different measurement tools. This could strengthen the reliability and validity of the results.

However, this study also has strengths. To our knowledge, this is the first study with a specific population of Portuguese highly engaged gamers. Also, information was collected on several important aspects of the lives of gamers: physical and mental health, nutrition during gaming, and sleep. This allowed us to gain more insight into the daily habits and health of this unique sample.

8. Conclusion

Poor sleep quality was observed in this population. Regarding all the other lifestyle indicators, we may only hypothesize. In summary, the studied sample apparently maintains a healthy lifestyle characterized by regular physical activity, good snacking habits while playing, and unproblematic gaming behavior, despite poor sleep quality. Players are not emotionally disturbed and present positive scores on the well-being scale, nevertheless borderline with the cut-off points. An interconnection between poor sleep quality, mental health issues (i.e., depression and anxiety), and poor diet quality has been frequently proposed. Future research is warranted to assess these findings after the global COVID-19 global pandemic and to further investigate possible correlations between nutrition, physical exercise, sleep patterns, and gaming.

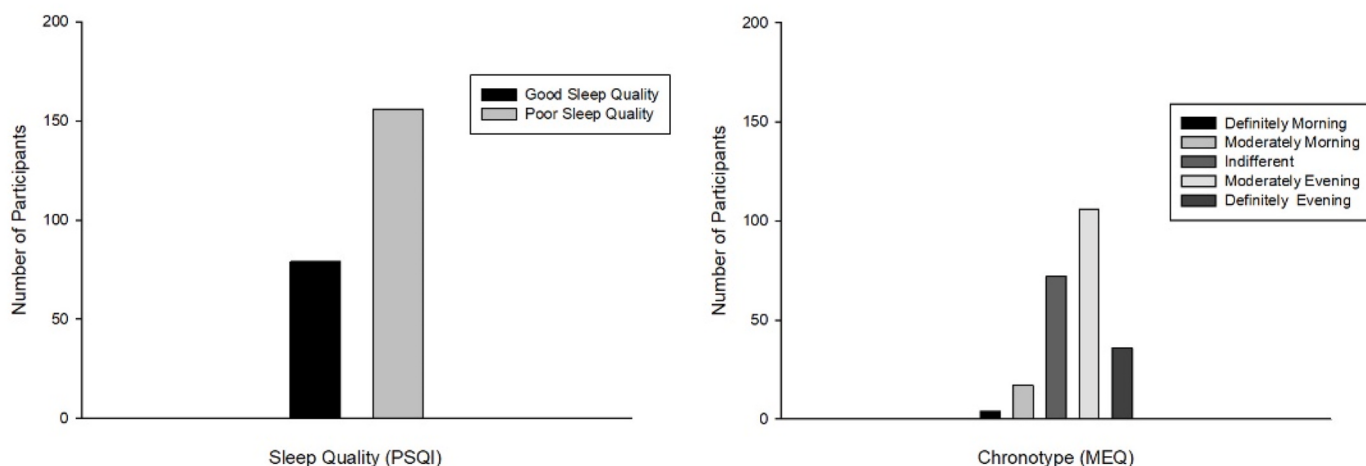


Fig. 4. Sleep Quality and chronotype according to the Pittsburgh Sleep Quality Index (PSQI) and the Morningness-Eveningness Questionnaire (MEQ).

Authorship

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

Data availability

Data will be made available on request.

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