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Sleep Characteristics of an International Sample of Adult Gamers

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Abstract

Introduction About 65% of adult Americans report playing video games. Despite potential impacts to functioning, there is limited research on the relationship between video game use and sleep, specifically among adults. The present study expands upon the literature by describing demographic, video game, and sleep characteristics of an international adult sample of gamers.

Methods The participants were 3,481 adults aged 18 to 74 who responded to an online questionnaire about video game use (i.e., quantity of play, most common game type), general sleep characteristics (i.e., sleep onset latency [SOL]; duration, sleep timing, and sleep quality), and gaming-specific sleep disruptors (i.e., game-related night awakenings and sleep delays). Most identified as cisgender male (79.8%) and white (77%).

Results Participants reported an average SOL of 24.63 minutes, and most (64.5%) had a sleep duration from 7 to 9 hours with an overall average of 8.42 hours. Most (58.7%) reported that their sleep quality was *fair* to *very poor*. Bed and wake times were generally delayed, with 51% reporting a late evening or early morning bedtime and an average wake time of 8:28 AM. A majority (81.2%) indicated that their bedtime was delayed due to game-related activities, but game-related night awakenings were less common.

Conclusion Although many report a sufficient amount of sleep, adult gamers tend to report sleep disruptions in other domains, particularly regarding a delayed sleep schedule and poor sleep quality. This may be attributable to game-related bedtime delays or other game-specific factors (e.g., game type) that should be evaluated in the future.

Keywords
- video games
- sleep disruption
- bedtime
- wake time
- adults

Introduction

In 2021, the video game industry was estimated to be worth 178.73 billion dollars.[1] In the United States, the prevalence rate of adult video game use was reported to be 65%, with a reported 3.2 billion gamers worldwide since 2021.[1,2] With such a large population engaged in video game use, it is important to better understand the potential effects of

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gaming on health. For example, it has been reported that 18 to 23% of adults use video game consoles before bed, and 11% of adults, at least sometimes, leave their video games on during the night when asleep.[3,4] Considering the engaging nature of video games and the possibility of evening light exposure during play, gamers may be at particular risk of poor sleep. However, research describing the sleep of adult gamers is limited.

There are biological and behavioral components to healthy sleep, both of which may be impacted by video game use. Behaviorally, an individual must disengage from the environment, including closing eyes, postural recumbence, and behavioral dormancy,[5,6] all of which are inconsistent with video game play. Biologically, there are two main mechanisms of control for sleep: the homeostatic drive that functions much like a battery, increasing the propensity for sleep with increased wakefulness, and the circadian rhythm that is responsible for levels of alertness.[7,8] First, in regards to the homeostatic drive, prior research has found that video game use is associated with an increased arousal response with decreases in subjective sleepiness, which may increase the amount of time a gamer engages in video game use.[9–11] Secondly, the circadian rhythm is influenced by environmental cues, especially light. Specifically, dimming light sources will initiate the release of melatonin, which promotes sleepiness and sleep onset. Conversely, exposure to natural or artificial light, such as that emitted from video games, may suppress the release of melatonin and delay sleep onset.[9,12] The potential impact of video game play on these processes may result in individuals sleeping and waking at later times due to a biologically-driven lack of subjective sleepiness and increased light exposure at night.[12] These factors may contribute to a cycle of video game light exposure, increased arousal, later bedtimes, decreased sleepiness, and, subsequently, more video game play.

Past research on the effects of video game use on sleep is limited and has focused mostly on youth. These studies have found that video game use is associated with increases in SOL, poorer sleep quality, increased daytime sleepiness, and decreased subjective need for sleep.[9,11,13] The relatively few studies on adults have similar findings to those from studies on children and adolescents. Specifically, recent research suggests that video game use among adults before bed is associated with decreased subjective sleepiness, shorter rapid eye movement (REM) sleep cycles, and daytime sleepiness.[10,14] Further, greater video game use has been found to be associated with worse sleep quality, insomnia, and delayed sleep schedules even when controlling for other relevant factors such as demographics, perceived stress, and exercise.[15] However, findings in adults are mixed, with some studies even suggesting improvements in sleep subsequent to playing non-action games.[11,16] Accordingly, there have been calls for more research to better understand the sleep of adult gamers.[17]

Although the body of literature is growing, research examining sleep in video game users has primarily utilized games that are now older and less popular, and with small sample sizes of children and adolescents who often exhibit problematic video game use as opposed to healthy gaming habits. There is a need for current research to examine sleep in adult video game users, regardless of problematic use, who play a variety of video game types. Thus, the aim of the current study is to describe various sleep characteristics (i.e., SOL, sleep duration and timing, sleep quality, game-related night awakenings, and game-related bedtime delay) among a large, international sample of adult gamers. Based on expert recommendations and prior research, it was hypothesized that adult gamers would report generally increased SOL, later sleep and wake times, short sleep, and poor sleep quality. Furthermore, it was hypothesized that game-related night awakenings and bedtime delays would be present. Demographics differences in sleep characteristics among this sample were also explored. Due to the exploratory nature of these analyses, a priori hypotheses were not made.

Materials and Methods

Participants

The participants of the study consisted of 3,481 adult video game players, aged 18 and over, recruited from online advertisements. Specifically, participants were recruited through advertisements on various game-related subforums on Reddit.com (Reddit, San Francisco, CA, USA). Inclusion criteria required participants to be at least 18 years old with the ability to read, understand, and write in English.

Procedures

An online survey was used to gather participant data. A web link was included in the advertisements that gave participants access to the study. Upon beginning the online survey, participants completed an informed consent. No compensation was provided. All procedures were approved by the Loma Linda University Institutional Review Board.

Measures

Demographic Variables

Demographic information was collected including participants' age, gender, race/ethnicity, country of origin, education, and occupational status. Due to difficulties with interpretation, for bivariate analyses including race/ethnicity, the *other* category was removed.

Video Game Characteristics

The quantity of play and most commonly played video game were self-reported by participants. Quantity was reported as the average number of hours played per day and per week. Type of video game played most often was placed into specific categories along with their respective descriptions (see ►**Appendix A** for categories and descriptions).

Sleep Behavior

Participants were asked to provide information regarding their sleep behavior on days when they played video games. Specifically, they provided free responses to average bedtime and wake time, sleep duration, and SOL all on days they play

video games. Participants' bedtime responses were organized into the following categories based on prior research[18]: early evening bedtime (8–10 PM), normal bedtime (10 PM–12 AM), late evening bedtime (12–2 AM), early morning bedtime (2–6 AM), and daytime bedtime (6 AM–8 PM). Sleep quality was defined as a person's satisfaction with their sleep experience and was assessed by asking participants to rate their sleep quality on a 5-point Likert scale (1 = very poor, 2 = poor, 3 = fair, 4 = good, 5 = very good). Game-related night awakening was defined as any awakening from sleep due to game-related content (e.g., waking to access time-based resources, waking to play with certain friends, waking with game-related thoughts). Game-related bedtime delay was defined as how often participants stayed awake later than intended for game-related reasons (e.g., caught up in game, staying up in anticipation of new content releases, waiting for certain people to play). Both game-related night awakening and bedtime delay were assessed using a 4-point Likert scale (1 = Never, 2 = Sometimes, 3 = Often, 4 = Always).

Analysis Plan

To describe the demographic (i.e., age, gender, race/ethnicity, education, country of origin, and occupational status), video game (i.e., quantity of play and type of game played the most), and sleep characteristics (i.e., SOL, game-related night awakening, game-related bedtime delay, sleep quality, sleep and wake times, and total amount of sleep obtained) of our adult sample, descriptives were used. Further, demographic differences in sleep characteristics were examined using correlation, chi-square test, and one-way analysis of variance (ANOVA). Due to issues with small sample size within specific categories, several variables were recoded for these bivariate analyses. Gender was recoded into three categories: cisgender male, cisgender female, and gender expansive, which combined all other gender categories. Game-related night awakenings were dichotomized into those never waking up for game-related reasons and those waking up sometimes, often, or always. Game-related bedtime delays were recoded into three categories: never, sometimes, and often/always. Bedtime categories were dichotomized into those reporting a *normal* bedtime (i.e., 10–12 AM) or an *abnormal* bedtime, which included all other categories (i.e., early evening, late evening, early morning, and daytime bedtimes). For chi-square analyses, when the expected frequency of a given cell was less than five, that category was removed, and analyses were re-run. This has been noted in the results section, when applicable.

Results

Demographic and Video Game Characteristics

Participants consisted of an adult sample between the ages of 18 and 74 (mean [M] = 25.11, standard deviation [SD] = 7.03), with 80.0% of the sample identifying as cisgender male. A majority of the sample identified as White (77.6%), with *some college education* as the most commonly reported education level (30.3%). In terms of country of origin, participants reported being from 81 countries. Approximately half (50.7%) reported being from the United States of America. Only countries that were reported by at least 1% of our sample are reported. Please refer to ►**Table 1** for full demographic information.

In regard to quantity of play, participants reported playing an average of 3.61 (SD = 2.19) hours per day and 21.84 (SD = 15.68) hours per week. People reported playing online first-person shooter games (29.5%), other role-playing games (18.8%), and action adventure/co-op games the most (12.3%). See ►**Table 2** for full breakdown of video game type.

Sleep Characteristics

With regard to describing the sleep of our sample on days when video games were played, participants woke on average at 8:28 AM (*SD* = 2:22). For bedtime categories, 40% of participants reported having a normal bedtime (10 PM–12 AM), 29% reported having a late evening bedtime (12–2 AM), 22% reported having an early morning bedtime (2–6 AM), 5% reported having a daytime bedtime (6 AM–8 PM), and 4% reported having an early evening bedtime (8–10 PM). Participants reported taking an average of 27.37 minutes to fall asleep after playing video games (SD = 25.95), with an average sleep duration of 8.42 hours (*SD* = 2.37). In terms of sleep quality, 4% reported very poor sleep quality, 17% reported poor sleep quality, 38% of participants reported fair sleep quality, 33% reported good sleep quality, and 8% reported very good sleep quality. Although a majority of participants (91%) reported no game-related night awakenings, 7.7% reported *sometimes* having game-related night awakenings, and nearly 1% reported *often* or *always* having game-related night awakenings. Furthermore, 60% of participants reported *sometimes* having game-related bedtime delays, with 18.7% reporting *often* and 2.5% reporting *always* having bedtime delays due to game-related content. Only 18.8% of participants reported having no bedtime delays due to game-related content. Please refer to ►**Table 3** for full sleep-related descriptive statistics information.

Demographic Differences in Sleep Characteristics

Age

Age was correlated with wake time ($r = -0.20$, $p < 0.001$), sleep duration ($r = -0.08$, $p < 0.001$), and SOL ($r = -0.07$, $p = 0.003$) such that as age increased, wake time was earlier and both sleep duration and SOL were shorter. Further, age differed by frequency of game-related bedtime delays, $F(2, 1818) = 14.53$, $p < 0.001$, such that those reporting *never* experiencing game-related bedtime delays (M = 27.27, SD = 8.28) were older than those reporting *sometimes* (M = 25.44, SD = 7.05), who were, in turn, older than those reporting *often* or *always* (M = 24.46, SD = 6.31). Age also differed by bedtime category, $F(1, 1821) = 23.77$, $p < 0.001$, such that those with a *normal* bedtime were significantly older (M = 26.50, SD = 7.88) than those reporting a bedtime falling during an *abnormal* time (M = 24.86, SD = 6.53). Age was not related to sleep quality, $r = 0.01$, $p = 0.571$, or game-related night awakenings, $F(1, 1819) = 2.97$, $p = 0.085$.

Table 1 Demographic descriptive statistics.

Demographics ($N = 3,481$)	*N*	Mean or %	Median	SD	Min	Max
Age	3136	25.11	23.00	7.03	18.00	74.00
Gender						
Male	2451	80.0				
Female	468	15.3				
Non-binary	51	1.7				
Female (transgender)	34	1.1				
Gender fluid	23	0.8				
Male (transgender)	17	0.6				
Agender	19	0.6				
Race/Ethnicity						
White	2291	77.6				
Asian or Asian American	249	8.4				
Mixed race	158	5.4				
Other	150	5.1				
Black or African American	64	2.2				
American/Alaska Native	29	1.0				
Native Hawaiian or other Pacific Islander	12	0.4				
Education						
Some high school	245	8.5				
High school diploma or GED	514	17.8				
Some college	874	30.3				
Undergraduate degree	666	23.1				
Some graduate education	165	5.7				
Graduate degree	421	14.6				
Country of origin						
United States of America	1469	50.7				
United Kingdom	205	7.1				
Canada	187	6.5				
Germany	126	4.4				
Australia	101	3.5				
France	55	1.9				
Netherlands	53	1.8				
Brazil	50	1.7				
Norway	45	1.6				
Poland	35	1.2				
Italy	35	1.2				
Sweden	32	1.1				
Finland	28	1.0				
Occupation status						
Student	1328	43.6				
Employed full time	1,169	38.4				
Unemployed	352	11.6				
Employed part time	196	6.4				

Abbreviation: SD, standard deviation.

Table 2 Descriptive statistics of type of video game played most ($N = 3,481$).

Type of video game	*N*	%
Online first-person shooter	687	29.50
Other role-playing games	437	18.80
Action adventure/co-op	287	12.30
MMORPGs	256	11.00
Other turn-based strategy games	140	6.00
Real-time strategy games	131	5.60
Competitive online fighting games	81	3.50
Free to play online casual games	64	2.70
Offline first-person shooter/co-op shooter	56	2.40
Board and/or card games	45	1.90
Survival horror/platform games	41	1.80
Puzzle games	39	1.70
Sports games	39	1.70
Driving/racing games	22	0.90
Gambling games	4	.20

Abbreviations: Co-Op, cooperative; MMORPGs, massive multiple online role playing games.

Gender

Wake time differed by gender, F (2,1821) = 9.44, $p < 0.001$, such that gender-expansive participants reported later wake times ($M = 9:31$ AM) than both cisgender males (M = 8:26 AM) and cisgender females (M = 8:17 AM), who reported similar wake times. Sleep duration also differed by gender, F (2, 1821) = 4.78, $p = 0.009$, with cisgender males reporting shorter sleep duration (M = 8.34, SD = 2.37) than cisgender females (M = 8.78, SD = 2.42). Gender-expansive participants reported a similar sleep duration (M = 8.55, SD = 1.90) as both cisgender males and females. Bedtime category also differed by gender, $\chi^2(2) = 10.52$, $p = 0.005$. Cisgender females were more likely to report a normal (versus abnormal) bedtime (51.56%) compared with both cisgender males (43.06%) and gender-expansive participants (35.29%). Finally, the likelihood of delaying bedtime for game-related reasons also differed by gender, $\chi^2(4) = 13.60$, $p = 0.009$. Cisgender males were less likely to report never delaying bedtime (17.22%) than cisgender females (25.94%). Gender-expansive participants were equally likely to report never delaying bedtime (18.82%) as both cisgender males and females. Cisgender males, cisgender females, and gender-expansive participants were also equally likely to report sometimes delaying bedtime (60.76%, 56.25%, and 60.00%, respectively) and often/always delaying bedtime (22.02%, 17.81%, and 21.18%, respectively). There were no differences in sleep quality, F (2, 1818) = 0.42, $p = 0.656$, SOL, F (2, 1737) = 1.02, $p = 0.361$, or game-related night awakenings, $\chi^2(2) = 0.47$, $p = 0.791$ by gender.

Race/Ethnicity

Chi-square analyses for game-related night awakenings resulted in expected cell frequencies of less than five for Native Hawaiian or Other Pacific Islander, American Indian or Alaskan Native, and Black or African American participants, and, thus, these categories were removed. There were differences in the likelihood of waking for game-related differences among the remaining racial categories, $\chi^2(2) = 7.59$, $p = 0.023$. Asian or Asian American participants were less likely to report never waking for game-related reasons (85.71%) when compared with White participants (92.50%), both of which were equally as likely as those identifying as mixed race (91.07%). Again, due to small, expected frequencies, the same racial categories were removed for chi-square analyses for game-related bedtime delays as were for game-related night awakenings. There were no differences in the likelihood of game-related bedtime delays for the remaining racial categories, $\chi^2(4) = 8.44$, $p = 0.077$. The category of Native Hawaiian or Other Pacific Islander was removed for the bedtime category analysis due to a small,

Table 3 Descriptive statistics of sleep variables ($N = 3,481$).

Sleep measures	Mean	SD
Wake time (HH:MM)	8:28	2:22
Sleep duration (hours)	8.42	2.37
Sleep quality	3.25	0.96
Sleep onset latency (minutes)	27.37	25.95
Game related night awakening	1.10	0.34
Game related bedtime delay	2.05	0.69
	N	%
Sleep quality		
Very poor	69	3.80
Poor	307	16.80
Fair	694	38.10
Good	601	33.00
Very good	151	8.30
Game-related night awakening		
No night awakening	1,667	91.40
Sometimes	140	7.70
Often	10	0.50
Always	6	0.30
Game-related bedtime delay		
No bedtime delay	343	18.80
Sometimes	1,093	60.00
Often	341	18.70
Always	46	2.50
Categories of bedtimes		
Normal bedtime (10 PM–12 AM)	733	40.1
Early evening (8 PM – 10 PM)	74	4.1
Late evening (12 AM–2 AM)	533	29.2
Early morning (2 AM – 6 AM)	397	21.7
Daytime (6 AM–8 PM)	89	4.9

Abbreviation: SD, standard deviation.

expected frequency, but, even when removed, there were no differences among the remaining categories, $\chi^2(4) = 7.31$, $p = 0.121$. Further, there were no differences in wake time, F (5; 1,712) = 0.692, $p = 0.630$, sleep duration, F (5; 1,712) = 1.85, $p = 0.100$, sleep quality, F (5; 1,710), $p = 0.900$, or SOL, F (5; 1,639) = 0.436, $p = 0.824$, by race/ethnicity.

Education

Wake time differed by education level, F (5; 1,817) = 7.03, $p < 0.001$. Those with a graduate degree reported an earlier wake time (M = 7:53 AM) than all others. Those with an undergraduate degree reported an earlier wake time (M = 8:17 AM) than those with some high school (M = 8:45 AM), a high school degree or GED (M = 8:53 AM), and some college (M = 8:37 AM). No other differences in wake time were observed. The likelihood of delaying bedtime for game-related reasons also differed by educational level, $\chi^2(10) = 28.13$, $p = 0.002$. The likelihood of reporting never delaying bedtime was equivalent for those with a graduate degree (24.57%), some graduate education (22.69%), an undergraduate degree (20.32%), and some high school (17.29%). Those with a high school degree or GED were less likely to report never delaying bedtime (14.95%) compared with those with a graduate degree but were equally likely when compared with those with some college (16.30%), some high school, an undergraduate degree, or some graduate education. The likelihood of reporting sometimes delaying bedtime for game-related reasons was equivalent for those with a high school degree or GED (65.45%), some college (61.90%), some graduate education (60.50%) and those with a graduate degree (58.13%). Those with some high school were equally likely to report sometimes delaying bedtime (49.62%) compared with those with an undergraduate degree (57.97%), some graduate education, and a graduate degree, but less likely than all other groups. Further, those with some high school were more likely to report often or always delaying bedtime compared with all other educational levels.

Finally, the proportion of participants with a normal versus abnormal bedtime significantly differed by education level, $\chi^2(5) = 13.78$, $p = 0.017$. The percentage of participants in each category reporting a normal bedtime include: some high school (38.35%), high school degree or GED (41.53%), some college (41.32%), undergraduate degree (47.70%), some graduate school (40.34%), and a graduate degree (51.56%). Those with a graduate degree were more likely to have a normal bedtime compared with all categories other than those with an undergraduate degree, which was equivalent. There were no statistical differences between those with some high school, a high school degree or GED, an undergraduate degree, or some graduate education. There were no differences in sleep duration, F (5, 1817) = 2.07, $p = 0.066$, sleep quality, F (5, 1814) = 1.60, $p = 0.156$, SOL, F (5, 1733) = 0.921, $p = 0.467$, or likelihood of waking for game-related reasons, $\chi^2(5) = 9.57$, $p = 0.088$, by educational level.

Country of Origin

There were differences in average SOL by country of origin, F (12, 1438) = 2.09, $p = 0.015$. Those from the United Kingdom reported the longest SOL (M = 37.12, SD = 41.49), which was statistically different from all other countries except Italy, Netherlands, Poland, and Sweden. The only other statistical difference was between those from Norway (M = 34.53, SD = 25.34) and Germany (M = 22.69, SD = 16.59). The likelihood of reporting a normal versus abnormal bedtime also differed by country of origin, $\chi^2(12) = 32.31$, $p = 0.001$. The percentage reporting a normal bedtime for each country were: Netherlands (67.50%), Australia (52.31%), Sweden (50.00%), Germany (48.31%), United States (48.14%), United Kingdom (47.50%), Brazil (44.44%), Norway (44.12%), Canada (42.06%), France (34.21%), Finland (19.05%), Poland (19.05%), and Italy (18.18%). Chi-square analyses for game-related night awakenings were associated with expected cell frequencies of less than five within the sometimes/often/always category for most countries (i.e., Brazil, Finland, France, Italy, Netherlands, Norway, and Poland). Even when these countries were removed, there were no differences, $\chi^2(4) = 2.09$, $p = 0.719$. Similarly, Finland, Italy, Poland, and Sweden were removed for game-related bedtime delay analyses but there were no patterns of differences, $\chi^2(16) = 16.43$, $p = 0.424$. There were also no differences in wake time, F (12, 1514) = 1.23, $p = 0.258$, sleep duration, F (12, 1514, $p = 0.088$, or sleep quality, F (12, 1511) = 0.862, $p = 0.586$, by country of origin.

Occupational Status

All sleep variables differed by occupational status. Specifically, there were significant differences in wake time by occupational status, F (3, 1821) = 46.31, $p < 0.001$. Wake times were statistically different for all groups with the exception of no differences between those who were unemployed (M = 9:34 AM) and those who had part-time employment (M = 9:26 AM). Those with full-time employment woke the earliest (M = 7:49 AM) followed by students (M = 8:41 AM), those with part-time employment, and those who were unemployed. There were also differences in sleep duration by occupational status, $F(3, 1821) = 5.14$, $p = 0.002$. Those with full-time employment (M = 8.16, SD = 2.38) slept statistically less than students (M = 8.62, SD = 2.38) and those who were unemployed (M = 8.60, SD = 2.10), but slept a statistically equivalent amount as those with part-time employment (M = 8.55, *SD* = 2.11). No other differences were observed for sleep duration and occupational status.

There were significant differences in sleep quality by occupational status, F (3, 1818) = 5.57, $p < 0.001$. Those who were unemployed reported poorer sleep quality (M = 3.00, SD = 1.05) than students (M = 3.27, SD = 0.96), those with part-time employment (M = 3.32, SD = 0.87), and those with full-time employment (M = 3.29, SD = 0.94), all of which did not differ from each other. There were significant differences in SOL on nights when video games are played by occupational status, F (3, 1737) = 7.17, $p < 0.001$. Those with full-time employment reported a shorter SOL (M = 24.37, SD = 21.51) than students (M = 28.95, SD = 27.07) and those who were unemployed (M = 33.01, SD = 32.85), but not those with part-time employment (*M* = 27.43, *SD* = 29.93). No other differences were

observed for SOL and occupational status. The likelihood of game-related night awakenings also significantly differed by occupational status, $\chi^2(3) = 21.80$, $p < 0.001$. Those with full-time employment were more likely to report never waking up (94.47%) compared with students (90.64%), those who were unemployed (87.06%), and those with part-time employment (84.35%). Those with part-time employment also statistically differed from students.

The frequency of game-related bedtime delays also differed by occupational status, $\chi^2(6) = 14.06$, $p = 0.029$. Students were less likely to report never delaying bedtime (15.78%) compared with those with full-time employment (21.34%), both of which were equally as likely as those with part-time employment (20.00%) and those unemployed (19.90%) to report never delaying. All groups were equally likely to report sometimes delaying bedtime. Those who were unemployed were more likely to report often or always delaying bedtime (25.37%) compared with those with full-time employment (18.45%), both of which were equally as likely as those with part-time employment (25.22%) and students (22.33%) to report often/always delaying bedtime. Finally, the likelihood of reporting a normal versus abnormal bedtime differed by occupational status, $\chi^2(3) = 59.72$, $p < 0.001$. Those who were unemployed were just as likely to report an abnormal bedtime (64.68%) as students (61.42%) and those with part-time employment (71.30%), who differed from each other. Those with full-time employment were less likely than all other categories to report an abnormal bedtime (45.52%).

Discussion

The current study aimed to describe various sleep characteristics and demographic correlates among a large, international sample of adult gamers. Consistent with our hypotheses, participants reported delaying bedtimes due to video game-related content, having a long SOL, high rates of poor sleep quality, and late bedtimes and wake times. Contrary to our hypotheses, participants reported an average sleep duration falling within clinical recommendations[19] and a low occurrence of game-related night awakenings. Notably, participants reported playing video games an average of 3.5 hours per day, which is higher than prior reported averages of 1.97 hours per day in American young adult players.[20]

In regard to SOL, participants reported taking ~ 24 minutes to fall asleep, which is slightly longer than what is considered to be ideal (i.e., 15–20 minutes[21]). It is possible that this longer SOL may be a sign of low levels of sleepiness or increased arousal before bed, which would be consistent with prior research indicating video game use decreases subjective sleepiness, especially when the video game played is high in action.[9,11] This may be further supported by the fact that the majority of the participants (81.2%) reported at least sometimes having game-related bedtime delays. It might be expected that delayed bedtimes would increase sleepiness and subsequently decrease SOL. However, from our sample the top three categories of video games reported to be played the most were online first-person shooter (such as Call of Duty or Halo), action adventure/co-op (such as The Legend of Zelda or Resident Evil 5), and other role-playing games (such as Diablo or Final Fantasy), which all contain stimulating gameplay. Research suggests that when adult gamers are engaged in stimulating video game use, this may increase bodily arousal and decrease perceived need for sleep, which, subsequently, may contribute to increased time to fall asleep.[9,11]

Although the average sleep duration of our sample fell within the recommended range of 7 to 9 hours, this may be skewed by individuals who oversleep. Specifically, although 64.5% of our sample reported a sleep duration of 7 to 9 hours (falling within clinical recommendations), 22% of the participants reported a sleep duration greater than 9 hours, and 13.5% reported sleep durations less than 7 hours. The negative consequences of short sleep are well documented[22]; however, long sleep durations also confer risk, including increased risk of mortality, diabetes mellitus, cardiovascular disease, stroke, coronary heart disease, and obesity.[22] Taking prior research on sleep and video game use into consideration, it was unexpected that nearly a quarter of participants slept more than 9 hours in the current study, considering most data up until this point have found video game use to be associated with shorter sleep duration.[23] These findings highlight the importance of future research on the relationship between sleep duration and video game use, examining such things as sleep phenotypes for gamers, directionality of effects, and mechanisms of this relationship.

With regard to sleep timing, participants reported an average wake time of 8:28 AM, with ~ 44.2% of the participants reporting a bedtime falling within the early-normal range (8 PM–12 AM[18,24]). However, 51% of our participants reported a late evening (12–2 AM) to early morning (2–6 AM) bedtime. One explanation for the later bedtimes could be related to the games that participants reported playing the most. Online first-person shooter (FPS) games (e.g., Call of Duty or Halo) were the games our participants reported playing the most, which contain matchmaking or rank game mechanics where players engage others in a set number of teams to obtain victory through an objective. Matchmaking systems usually have participants play in short durations of time with a start and finish design. However, many of these types of games also cause players to lose *rank* points if they are defeated, which may motivate players to continue to play more matches to regain lost points. Furthermore, many rank systems match players randomly with other players of similar skill with win rates of 48 to 52%, which, in turn, creates about a 50% chance that a player will win or lose a match. One of the reasons that could explain the later bedtimes is that players may be influenced by the gambler's fallacy, which states that a person may believe that a random event is less likely or more likely to happen based on the outcome of a previous event.[25] In this case, players may engage in a larger number of matches to achieve a positive win ratio, especially when players have lost matches or rank points, because there is a 50% chance of winning each game. In other words, players who lose matches may continue to

play to achieve a positive win ratio, which consequently delays their bedtimes due to game-related reasons. One other explanation for early morning bedtimes could be from participants working night shifts that would lead participants to report early morning bedtimes.

In addition, it was found that participants tended to wake at slightly later morning hours ($M = 8{:}28$ AM) and about a quarter reported, on average, greater than normal sleep durations, which is contrary to our hypothesis for sleep duration but not for wake times. It is likely that the slightly later wake times were influenced by the later bedtimes discussed above. Further, it is notable that a large percentage of our participants indicated they had *some college education*, perhaps suggesting they are college students with more flexible morning schedules. Specifically, one explanation for the later wake times and greater sleep durations might be that 61.6% of our sample were students, employed part time, or unemployed, which is likely to translate into more flexible wake times and longer sleep duration as a result. However, it is also possible that adult gamers' wake times and sleep duration are impacted differently by type of video game played. For example, the three games that participants reported playing the most were primarily online FPS, other role-playing games, and action adventure/co-op, which contain stage levels or matches that have short durations of play with a start and end design.

Although the majority of the participants reported having no game-related night awakenings, 8.6% of gamers indicated that they at least *sometimes* wake up for game-related reasons. In addition, results indicated that 58.7% of participants reported *fair* to *very poor* sleep quality. Findings from child and adolescent research using objective measures suggest that sleep quality after prolonged video game use is negatively affected.[12,26,27] Furthermore, studies using adult samples suggest that the intensity of video games has a negative impact on sleep quality, with the average participant reporting *poor* sleep quality.[28] Our findings may suggest that adult gamers' reported sleep quality overall is negatively impacted, similar to child or adolescent gamers, and, therefore, may warrant further study. This should include a closer examination of game-related night awakenings.

In addition to describing overall sleep characteristics in an adult sample of gamers, we explored demographic correlates, which may further contextualize the overall findings. Of the demographic factors examined, occupational status was the most consistent correlate of sleep. It appears that full-time employment may be protective against potentially unhealthy or abnormal sleep behaviors. For example, those with full-time employment were less likely to report game-related bedtime delays or night awakenings and were more likely to wake earlier (which may or may not be associated with health, depending on factors such as circadian alignment and overall sleep duration). While they reported a shorter sleep duration, it is notable that the average was $\sim$ 8 hours per night, still well within clinical recommendations. It is possible that students or those with part-time or no employment tend to oversleep, raising the average sleep durations for these groups. Educational status, which is likely related to occupation, also had similar differences. Those with advanced degrees (i.e., graduate or undergraduate degrees) tended to report waking earlier, and the likelihood of reporting a normal bedtime increased with educational level. Finally, as age increased, participants tended to report going to bed earlier, falling asleep quicker, having less frequent game-related bedtime delays, and being more likely to report a normal bedtime. As age, education, and careers advance, external demands (e.g., caretaking duties, occupational responsibilities, financial concerns) may also increase in ways that improve structure and routines and/or change priorities that subsequently impact sleep and gaming behavior. Future research should examine how external demands influence gaming behavior and serve as protective or risk factors in this population.

This study was not without limitations. First, although we had a large international sample, our external validity may still be limited as most of our sample consisted of White, cisgender males from the United States of America. Secondly, we report sleep characteristics descriptively using a cross-sectional design and cannot infer causality or directionality of effects; experimental and longitudinal studies are needed. Specifically, studies that examine sleep patterns before an individual begins using games are needed. It is possible that specific sleep patterns (e.g., a tendency toward a later bedtime, chronotype) predict game use as opposed to game use leading to these sleep patterns. Third, only self-reported measures were utilized, which may have led to recall and social desirability biases. Self-report data may be biased or less accurate than more objective assessments of sleep (e.g., actigraphy). Relatedly, while many of the included questions about sleep (e.g., bedtime, wake time, sleep duration) are commonly used in epidemiological studies, previously validated measures were not used which may limit confidence and interpretability of the data. The field would benefit from the development of a questionnaire specific to video game-related sleep deficits. Next, not all aspects of sleep were evaluated. For example, sleep variables were only collected at one time point. Differences in weekday versus weekend sleep, or sleep variability in general, may be related to video game use and are known to impact health more broadly. Last, while our international sample can be viewed as a major strength, the fact that many non-native English speakers completed the survey in English may introduce potential error.

Conclusions

This study aimed to describe various sleep characteristics in a large, international sample of adult video game users. Results suggest adult video game players have disturbances in self-reported SOL, sleep duration, sleep quality, and bed and wake times. Furthermore, the majority of participants indicated that bedtime is delayed from game-related activities but is not a major cause of night awakenings. Increased age, advanced education, and full-time employment may be protective factors in regard to sleep in this population. This study extends current knowledge of sleep characteristics in a

sample of adult video game players. Future research is needed to understand aspects of video games (e.g., game type and mechanics) and individual characteristics (e.g., chronotype, problematic video game use, mental health comorbidities, external demands) that may put players at increased risk of sleep problems. Further, objective sleep assessments, such as actigraphy, should be utilized in future studies to replicate the present findings.

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Conflict of Interests
The authors have no conflict of interests to declare.

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Appendix A

Video Game Category Descriptions

(1) Massive multiplayer online role-playing games (MMORPGs), which consist of an online, shared, competitive world with character development and interactions such as World of Warcraft or Guild Wars 2.
(2) Other role-playing games, are video games that are usually single-player games with a rich narrative, such as Diablo or Final Fantasy.
(3) Online first-person shooter, which are games consisting of online kill or be killed matches, such as Halo, Call of Duty, Left 4 Dead, or Quake.
(4) Offline first-person shooter/co-op shooter, which are games that have offline kill or be killed games from a first person perspective, such as Bioshock or Doom.
(5) Free to play online casual games are games in which the player logs on every day and tends to virtual worlds, such as Farmville, The Simpsons: Tapped Out!, Plants versus Zombies Adventure, Free Realms, or Puzzle & Dragons.
(6) Competitive online fighting games, which are fighting games in the third-person perspective, such as Street Fighter or Super Smash Bros: Brawl
(7) Real-time strategy games, which are games that contain strategic combat-oriented games with no wait between moves, such as Starcraft, Dota, ANNO 2070, Dawn of War, Total War Warhammer, and Age of Empires.
(8) Action adventure/co-op action, which are games oriented toward combat and exploration, mostly in third-person perspective, such as Hitman, Dark Souls, The Legend of Zelda, or Tomb Raider.
(9) Sports games, which are games oriented toward sports and workout type activities such as Madden, NBA Jam, and Tiger Woods.
(10) Driving/racing games, which are games such as Need for Speed, Super MarioKart, or Forza.
(11) Other turn-based strategy games, which consist of turn-based strategic simulation such as Civilization, X-Corn, Heroes of Might and Magic, or Tower Defense.
(12) Gambling games, which consist of simulated games, such as poker, black jack, and slot machine gambling.
(13) Board and/or card games, which are games that simulate card games without gambling, such as Magic the Gathering, Scrabble, Settlers of Catan, or Monopoly.
(14) Puzzle games, which are games that involve matching, logic, deductive reasoning and other puzzles, such as Portal, World of Goo, or Angry Birds.
(15) Survival horror/platform games, which are games that require precision movement and jumping, such as Super Mario Bros., Sonic the Hedgehog, Super Meat Boy, Amnesia: The Dark Descent, and Resident Evil series.

