

Sleep Characteristics and Risk Factors of Korean Esports Athletes: An Exploratory Study

Sangha Lee, PhD¹, Daniel Bonnar, MPsych², Yeji Kim, BA³, Yoojin Lee³,
Sunkyung Lee⁴, Michael Gradisar, PhD², Sooyeon Suh, PhD, DBSM³

¹Department of Psychiatry, Ajou University School of Medicine, Suwon, Korea

²College of Education, Psychology and Social Work, Flinders University, Adelaide, Australia

³Department of Psychology, Sungshin Women's University, Seoul, Korea

⁴Department of Psychology, Korea University, Seoul, Korea

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Correspondence

Sooyeon Suh, PhD, DBSM
Department of Psychology,
Sungshin Women's University,
2 Bomun-ro 34da-gil, Seongbuk-gu,
Seoul 02844, Korea
Tel +82-2-920-7215
Fax +82-2-920-2040
E-mail alysu@sungshin.ac.kr

ORCID

Sangha Lee
<https://orcid.org/0000-0002-7042-2052>
Daniel Bonnar
<https://orcid.org/0000-0001-7528-3023>
Yeji Kim
<https://orcid.org/0000-0001-6113-8116>
Yoojin Lee
<https://orcid.org/0000-0002-5994-3420>
Sunkyung Lee
<https://orcid.org/0000-0003-2231-7247>
Michael Gradisar
<https://orcid.org/0000-0002-5146-2657>
Sooyeon Suh
<https://orcid.org/0000-0003-0644-8634>

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Background and Objective Although sleep is a potentially important determinant of performance in esports, there have been no published data on the sleep behavior of professional esports athletes. The aim of this study is to investigate sleep aspects and sleep risk factors in esports athletes.

Methods Thirty-four esports athletes were compared with 21 nonathletes from the general population to assess their sleep patterns and mood. Study 1 is a quantitative study with a 2-week observation period of sleep that was performed after evaluating insomnia severity, daytime sleepiness, sleep knowledge, and mood state. During the sleep observation period, participants recorded sleep diaries. In study 2, qualitative research was conducted with in-depth interviews from 6 participants.

Results The esports athlete group reported significantly delayed sleep phase compared to the nonathlete group ($d = 2.10$ hours, $p < 0.001$). The esports athlete group reported significantly lower sleep quality and scores for feeling refreshed upon awakening, higher depression scores and significantly higher proportion of individuals with clinical symptoms of depression compared to the nonathlete group ($ps < 0.01$). In study 2, six themes emerged from the interviews: sleep risk factors, sleep protective factors, lifestyle, stressors, organizational management, and demands for sleep/psychological intervention.

Conclusions The professional esports athletes showed more depressed mood and more delayed sleep phase compared to the non-athletes. A wide range of interventions tailored to esports athletes should be developed and implemented on both individual and organizational levels.

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Key Words Esports, Sleep, Mixed-method research, Risk factors.

INTRODUCTION

Esports (electronic sports) refers to a new type of sports competition in which individuals or teams play a video game competitively. The esports industry is now one of the most rapid-growing industries, and professional esports athletes have become role models for adolescents. It has been reported that the global esports revenues are projected to grow to \$1.1 billion by 2020, with an estimated 495 million global viewers for esports events [1].

In contrast to the growth of esports as an industry, management and support for esports athletes remain underdeveloped—especially in the domain of mental health. A previous study reported that 63% of participants had worse health than before they became esports athletes, with a majority of esports them reporting stress-related disorders, depression, anxiety disorders, and insomnia [2]. However, the reasons for increased risk of psychological issues in esports athletes remains unexplored. To date, to the best of our knowledge, there have been no

empirical studies investigating psychological and sleep-related problems of esports athletes comparing them to nonathlete counterparts [3,4].

Sleep is an important factor that may affect the performance and mental health of esports athletes [5,6]. Sleep has been shown to impair a broad spectrum of cognitive functions (e.g., attention, working memory, executive functioning) [7,8] and increase negative emotions [9]. The negative effects of sleep deprivation on mental health have been repeatedly confirmed through various prior studies (e.g., sleeping 6 hours a day for a week resulted in fatigue and overall mood degradation) [7]. Given the effect of sleep on mood and performance [10] and the high burnout rate of esports athletes, this finding should be considered important [11]. In addition, esports athletes may be at an increased risk of sub-optimal sleep due to long training hours, high consumption of caffeinated beverages, frequent travel to different time zones due to matches, and the nature of competitive esports (e.g., pre-competition worries, gaming culture) [3,4], which could therefore also compromise performance and mental health.

Using quantitative research, it is possible to examine the overall status and factors, of esports athletes' sleep patterns and mental health. However, quantitative research does not 1) sufficiently inform us about the underlying issues esports athletes experience in preventing sleep problems, 2) the context in which they respond, and 3) the thoughts and actions that control their responses [12]. In particular, sleep is influenced by both the psychological traits of individuals and external environmental factors. For example, cognitive processes as outlined by Harvey [13], including selective attention and monitoring, distorted perception of sleep and daytime deficits, erroneous beliefs, and counterproductive safety behaviors, can worsen sleep. Additionally, environmental factors such as noise, excessive light, and stimulant use can also negatively impact sleep outcomes [14]. To reveal specific in-depth perceptions and experiences, qualitative research is needed to explore participants' lifestyles, relationships, occupational characteristics, emotions, and subjective recognition. Indeed, there are benefits from using a mixed-methods design (i.e., combining quantitative and qualitative research methods) as they provide insights through quantitative analysis and rich information when converging on the same research questions [15].

Therefore, this study aims to promote a diverse and in-depth understanding of esports athletes' sleep experiences through mixed-methods research. The current study aims to identify the characteristic sleep patterns of and risk factors among Korean esports athletes and to examine the relevance of these features to athletes' emotions. These variables of interest will be compared against a nonathlete group. These investigations may establish basic data on the overall sleep of esports athletes and provide information about the relevance of sleep and emotions. In addition, we expect to provide basic data for developing sleep interventions for esports athletes in the future.

STUDY 1: QUANTITATIVE STUDY OF SLEEP IN ESPORTS ATHLETES

METHODS

Subjects

We contacted 5 professional teams to participate in the study from August to December 2019. A description of the study was provided to prospective participants after which voluntary consent was obtained. All tests were conducted in each team's living headquarters. Fifty-five males (average age, 20.41 ± 2.40 years; age range, 16–25 years) participated in study 1. Thirty-four Korean elite esports athletes playing in professional leagues were compared to 21 age- and sex-matched nonathletes. Participants under treatment for sleep disorders and those suffering from other psychiatric disorders were excluded as determined by their medical histories and prior phone interviews. Ethics approval was obtained from Sungshin Women's University Institutional Review Board (No. of Approval: SSWUIRB 2019-030-001).

Procedure

The current study examined two weeks of sleep patterns for all participants. Self-report questionnaires were conducted at baseline, and all subjects were asked to record sleep diaries for 2 weeks. After 2 weeks of sleep monitoring, participants were provided with brief individual feedback for compensation.

Measures

Sleep pattern evaluation tool

Sleep diary

Sleep diaries were collected for 2 weeks to analyze participants' sleep patterns. The following sleep indices were collected through the sleep diaries: bedtime (BT), lights out (LO), sleep onset (SO), sleep onset latency, wake after sleep onset (WASO), waking time (WT), time out of bed (TOB), sleep quality (SQ), time in bed (TIB), total sleep time (TST), sleep efficiency (SE) and feeling refreshed upon awakening (FR).

Self-report psychological evaluation tool

Perceived Stress Scale

This scale consists of two separate subfactors including positive perception and negative perception. Positive perception measures the degree of awareness when individuals were not overwhelmed by a situation and recognized the predictability of and their own control over what happened in their environment. Negative perception measures stress levels when individuals perceive an overwhelming situation that is unpredictable and out of control. A total of 10 questions were scored from 0 (= not

at all) to 4 (= very often). The total score ranges from 0 to 40. The internal consistency (Cronbach's α) in this study was 0.87.

State-Trait Anxiety Inventory-State

To estimate the level of anxiety experienced by esports athletes, the State-Trait Anxiety Inventory-State (STAI-X-1) was used. The scale includes 40 questions, 20 for measuring state anxiety, and 20 for measuring trait anxiety. Considering the research purpose, which is measuring anxiety as a sleep-related condition and not as a personal trait, only the state anxiety test was used among the questionnaires. Each item was scored with a 4-point Likert scale from 1 to 4, and a total score (ranging from 20–80) was calculated by summing individual item scores, with higher scores indicating greater levels of state anxiety. The internal consistency (Cronbach's α) in this study was 0.85.

Center for Epidemiologic Studies Depression Scale

The Center for Epidemiologic Studies Depression Scale (CES-D) is a self-report scale to screen for depression [16]. The CES-D is useful as a simple screening test for clinical depression patients and is frequently used since it makes it easier to measure depression in the general population or patients who are experiencing physical pathology [16]. There are 20 items that use a 4-point Likert scale (0 to 3). Items are summed to generate a total score (ranging from 0–60), with higher total scores indicating more severe levels of depression. In this study, participants who scored more than 16 points were regarded as a high-risk group. The internal consistency (Cronbach's α) in this study was 0.96.

Insomnia Severity Index

The Insomnia Severity Index (ISI) consists of a 7-item five-point Likert scale (0–4) that measures the severity of insomnia experienced during the previous two weeks, satisfaction with current sleep, degree to which daytime functions are interrupted by sleep problems, and worries about sleep [17]. The total ISI score ranges from 0 to 28, and a higher score indicates more severe insomnia. A cut-off score of 10 had 86.1% sensitivity and 87.7% specificity for detecting insomnia cases in community samples [18]. The internal consistency (Cronbach's α) in this study was 0.80.

Sleep knowledge

Sleep and performance knowledge was measured using a quiz adapted from Bonnar et al. [19]. The quiz consisted of a total of 16 items that identify the level of general knowledge about sleep and performance [e.g., "Most young adults (aged 18–25 years) need seven to nine hours of sleep a day"]. Participants answered "true," "false" or "don't know." Correct answers were scored 1 and incorrect and "don't know" responses as 0. Individual item scores were summed to generate a total score out of 16, with higher total scores indicating greater knowledge.

Pediatric Daytime Sleepiness Scale

The Pediatric Daytime Sleepiness Scale (PDSS) is an 8-item measure of daytime sleepiness that uses a 5-point Likert scale ranging from 0 to 4 [20]. It was originally invented to measure daytime sleepiness in children and adolescents but was chosen over other popular sleepiness scales (e.g., the Epworth Sleepiness Scale) because its items show greater face validity (i.e., questions aimed at morning sleepiness that are typically experienced by participants in the age range of esports athletes, i.e., adolescents and young adults). The wording of items 1 and 2 was altered to increase their relevance to esports athletes because the original items were school related and none of the participants were attending school. A score of more than 15 points indicates excessive weekday sleepiness [21]. The scale has been validated for use in studies of children, adolescents, and young adults [22]. The internal consistency (Cronbach's α) in the study by Drake et al. [20] was 0.80, and it is 0.62 in this study.

Statistics

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics including means and standard deviations were used to summarize variables. For data composed of continuous variables, t-test or analysis of variance was used, and for the response rate, a chi-square test was used.

RESULTS

Demographics

Thirty-four esports athletes of two major esports genre in Korea [Multiplayer Online Battle Arena (MOBA) and First Person Shooter (FPS)] were recruited from a total of five professional teams. They were all males who played an average of 13.56 (± 1.63) hours per day. The mean age difference between the esports athlete group (20.41 ± 2.40 years) and nonathlete group (21.95 ± 2.92 years) was not significant. There were 3 adolescents included in the esports athlete group, but no adolescents in the control group. There were also no differences in their body mass index and caffeine consumption. Demographic information can be found in Table 1.

Sleep Characteristics

Sleep characteristics of esports athletes derived from the sleep diaries were as follows: the mean TST of esports athletes was 436 (± 73) minutes, which was 27 minutes longer than that in the nonathlete group, but there was no significant difference. The average BT of esports athletes was 4:04 a.m., which is significantly later than that of nonathletes at 2:18 a.m. ($t = 5.588$, $p < 0.001$). The lights off ($t = 4.887$, $p < 0.001$) and SO ($t = 6.026$, $p < 0.001$) times of esports athletes were also significantly later than the average times for the nonathlete group. The number of

Table 1. Demographic information of participants (n = 55)

Variable	Esports athlete	Nonathletes	p-value
Age (years)	20.41 ± 2.40	21.95 ± 2.92	0.050
BMI (kg/m ²)	24.24 ± 5.39	23.50 ± 2.93	0.580
Average daily game time (game playing hours/day)	13.56 ± 1.63	1.36 ± 1.02	< 0.01*
Sex, male	34 (100)	21 (100)	
Age			
10's	10 (29.4)	5 (20.8)	
20's	24 (70.6)	16 (66.7)	
Caffein consumption	21 (61.8)	13 (54.2)	0.536†

Data are presented as mean ± standard deviation or n (%). *p < 0.01. †Chi-square test.

Table 2. Subjective sleep patterns of esports athletes compared to non-esports athletes

Variable	Esports athletes (n = 34)	Non-esports athletes (n = 21)	p-value
TST (minutes)	436 ± 73	415 ± 12	0.182
BT (hh:mm)	4:04 ± 0:59	2:18 ± 1:21	< 0.01*
LO (hh:mm)	4:35 ± 1:03	2:57 ± 1:25	< 0.01*
SOL (minutes)	22.51 ± 24.60	13.05 ± 7.32	0.093
SO (hh:mm)	5:04 ± 1:00	2:58 ± 1:11	< 0.01*
WASO (minutes)	12.39 ± 21.80	9.72 ± 7.62	0.593
NWAK (times)	1.25 ± 1.71	1.31 ± 1.25	0.875
WT (hh:mm)	12:13 ± 0:47	10:09 ± 1:29	< 0.01*
TOB (hh:mm)	12:33 ± 0:42	10:13 ± 1:31	< 0.01*
TIB (minutes)	529 ± 71	494 ± 84	0.222
SE (%)	82.55 ± 9.46	84.53 ± 5.83	0.383
Sleep quality	2.75 ± 0.46	3.34 ± 0.67	< 0.01*
Freshness	2.63 ± 0.45	3.10 ± 0.54	0.002*

Data are presented as mean ± standard deviation. *p < 0.01.

TST: total sleep time, BT: bed time, LO: lights out, SOL: sleep onset latency, SO: sleep onset, WASO: wake after sleep onset, NWAK: number of awakening, WT: wake-up time, TOB: time out of bed, TIB: time in bed, SE: sleep efficiency.

awakening of esports athletes was 1.25 (± 1.71) times on average during sleep, and the average WASO time was 12.39 (± 21.80) minutes; both results were not significantly different from those of nonathletes (Table 2). The average WT of esports athletes was 12:13 p.m. (± 47 minutes), which was significantly more delayed than that of the nonathletes (10:09 ± 89 minutes; t = 6.681, p < 0.001), and the TOB after awakening among esports athletes was also delayed by more than two hours compared with the nonathletes (t = 7.028, p < 0.001). The SQ (t = -3.156, p < 0.001), which was measured on a 5-point Likert scale, and the FR (t = -2.857, p < 0.001) of esports athlete group were

Table 3. Sleep and clinical indices for esports athletes and non-athletes

Variable	Esports athletes (n = 34)	Non-esports athletes (n = 21)	p-value
PDSS			
Mean ± SD	16.65 ± 5.13	14.43 ± 5.31	0.135
n of high risk (%)	24† (70.6)	11 (52.4)	0.173‡
ISI			
Mean ± SD	8.97 ± 4.13	8.05 ± 5.27	0.508
n of high risk (%)	14† (41.2)	7 (33.3)	0.561‡
STAI-X-1			
Mean ± SD	39.09 ± 11.24	36.10 ± 9.67	0.300
n of high risk (%)	4† (11.8)	2 (9.5)	0.796‡
CES-D			
Mean ± SD	21.29 ± 14.11	9.76 ± 8.28	0.001*
n of high risk (%)	22† (64.7)	3 (14.3)	< 0.01**
PSS			
Mean ± SD	16.09 ± 1.64	16.00 ± 0.92	0.960
Sleep quiz			
Mean ± SD	46.35 ± 13.94	55.93 ± 11.73	0.010*

*p < 0.01. †Derived only when cut-off is present. ‡Chi-square test. SD: standard deviation, PDSS: Pediatric Daytime Sleepiness Scale, ISI: Insomnia Severity Index, STAI-X-1: the State-Trait Anxiety Inventory-State, CES-D: Epidemiologic Studies Depression Scale, PSS: Perceived Stress Scale.

rated significantly lower than the nonathlete group.

Insomnia, Daytime Sleepiness, and Emotional Regulation

Information from self-report questionnaires is presented in Table 3. There were no significant differences in either the severity of insomnia or daytime sleepiness among esports athletes and nonathletes. However, the mean daytime sleepiness score among esports players exceeded the cut-off (15 points), indicating that esports athletes experienced high levels of sleepiness during the day. Esports athletes scored significantly higher in depression (t = 3.818, p < 0.01), with a higher proportion of esports athletes scoring above the clinical cut-off value (CES-D > 16) for depression than the proportion of nonathletes (64.7% vs. 14.3%, p < 0.001). However, the levels of anxiety (STAI-X-1) and perceived stress (Perceived Stress Scale) among esports athletes were not significantly different from those among nonathletes. The scores of the sleep quiz, which measures general knowledge about sleep, were significantly lower in esports players than in nonathletes (46.35 vs. 55.93, respectively; p < 0.01).

STUDY 2: QUALITATIVE STUDY OF ESPORTS' PLAYERS AND COACHES' SLEEP

METHODS

Data collection. Three volunteers from the participants of study 1 and three of their coaches attended the study 2 underwent the semi-structured interview. We reviewed the baseline questionnaires, which described their experiences and thoughts, examined the esports athletes' sleep patterns and asked additional questions. In the process of organizing the questions, the questionnaire used in an existing phenomenological qualitative study of sleep disorders was referenced [23]. Interview instructions were developed, and the interviews were supervised by a clinical psychologist who is also a behavioral sleep medicine specialist.

Each of the questions presented in the interview addressed particular topics or areas including health conditions, relationship, work, and life as an esports athlete, and sleep. Some examples of the seed questions used to prompt the interviews can be seen in Table 4. The progression of the questions was not equivalent for all participants and varied based on interviews and participants' responses. However, based on the interview instructions, researchers could gather similar forms of information from all participants. In this way, researchers could save time and decrease the collection of unnecessary information compared with

unstructured interviews [24]. Researchers could create or add questions even if they were not included in the guidelines [25]. In this study, the analysis method of Giorgi [26] was used to explore the meaning and nature of risk factors associated with sleep patterns of esports athletes. The stages of analysis method based on Giorgi are: 1) read the description for the sense of the whole, 2) divide the description into meaning unit, 3) transform meaning units into best disciplinary expression, 4) synthesize transformed meaning units into structure. NVivo12 (QSR International, Melbourne, Australia) was used to analyze the qualitative data.

RESULTS

After transcribing the recorded files, 191 meaning units were derived from the analysis of the data. Ultimately, 138 final meaning units were obtained. These were classified into 30 components according to similar attributes and organized into the following 6 categories: 'life of an esports athlete,' 'stressor,' 'sleep risk factor,' 'sleep protective factor,' 'need for intervention,' and 'team management.' The examples of participant quotations by category are shown in Table 5 and the structure of sleep and sleep risk factors and life factors of esports athletes is shown in Fig. 1.

Table 4. Seed questions used in the semi-structured interviews

Stage	Examples of seed questions
1. Introduction	How do you feel to have a new season with new members?
2. Facilitation	<p>1) Topic 1: health</p> <p>How do you take care of your health?</p> <p>Are you participating in any health care programs?</p> <p>If health care programs are provided, what kind of assistant would you like to receive?</p> <p>You seem to go to bed very late and wake up in the middle of the day, did you have that kind of lifestyle before becoming a pro?</p> <p>2) Topic 2: relationship</p> <p>Since teamwork is important for the game, the relationship between the teammates really matters, I wonder who the players are close with you and how you solve the conflicts.</p> <p>You seem to stay together for training almost all day of the year, how often do you meet your family?</p> <p>Could you tell me if you've ever had a hard time with coaches, players, or others, or you've ever seen a player who experience this situation?</p> <p>3) Topic 3: job and life</p> <p>What kind of value do you think does an esports athlete have?</p> <p>Do you have any special plans after retiring?</p> <p>What is the best part and the hardest part?</p> <p>4) Topic 4: sleep</p> <p>How have you been sleeping lately? Do you have any particular concerns about sleeping?</p> <p>If a sleep enhancement program for esports athlete is provided, what would you like to get help particularly?</p> <p>If a stress management program for e-sports athlete is made, would you like to utilize it?</p>
3. Closing	Is there anything else you'd like to add?

Table 5. Examples of participant quotations by category

Category	Components and quotations
Sleep risk factors	Delayed sleep phase “You need someone to play against during scrimms, right? We can’t just compete amongst ourselves. And that’s the time that all the other teams are doing their scrimms, so we have to stay up late.” (participant 1)
	Environmental factors disturbing sleep “He snores a lot. So I try to go to bed before him, but sometimes I sleep later than him.” (participant 2)
	Lack of health care “I don’t think the participants do anything extra for their health.” (participant 1)
	Difficulty of jet lag adaptation “I can’t sleep on the plane... My sleep patterns kind of get messed up.” (participant 1)
	Mistaken efforts to improve sleep “I go to the gym and work out really hard. I try to get so tired that I can fall asleep faster when I go back home after I take a shower.” (participant 2)
	Personal sleep disturbance factors “Sometimes I get nervous before a match and can’t sleep.” (participant 2)
	Sleep protective factors
Environmental factors which are helpful for sleep “I think environmental factors are also important. In Korea, our headquarters and training rooms are only a 5-minute walk away, so even if things run late, it’s easy to get back to the headquarters and sleep in, because we can get to the training rooms easily. But here (in the States), we have to take an Uber and it takes about 10 minutes.” (participant 4)	
Appropriate efforts to improve sleep “I try to be on my cell phone less, like 30 minutes? Before I go to sleep.” (participant 3)	
Stressors	Burden of performance “You feel guilty, you can’t really say anything. There really isn’t anything you can say.” (participant 3)
	Job uncertainty “The whole profession overall is stressful and has a lot of anxiety factors.” (participant 5)
	Lack of social support “I’m not with friends or family. So if we don’t win a game, It’s really hard on me mentally.” (participant 1)
	Competition for starting line up “Players on the substitution roster think, what if I’m on the bench forever and just get traded from team to team until I’m done? It’s stressful.” (participant 4)
	Discord with team members “It’s hard if you have a teammate who plays differently from you. The bad feelings keep building up, and it’s bad when things blow up.” (participant 3)
Life of an esports athlete	Family relationship “My parents told me to study hard, and I didn’t listen. It’s similar. They were really against me becoming an esports athlete at first.” (participant 3)
	Life before becoming an esports athlete “Before I became a professional, I played at internet cafes a lot. After I became a pro, I bought a computer.” (participant 3)
	Changes after becoming an esports athlete “One thing I noticed after becoming a professional gamer is that I don’t sleep or eat a lot. With eating, it’s all or nothing. I either eat a lot, or don’t eat at all. There’s no middle ground.” (participant 2)
	Evaluation of a career as an esports athlete “If you make it big, you’re golden, but if you don’t, you’re doomed. It’s like a gamble.” (participant 2)
	Hobbies and leisure “Everything is the same except for gaming. I watch Youtube on the internet.” (participant 6)

Table 5. Examples of participant quotations by category (continued)

Category	Components and quotations
Team management	Team atmosphere “The psychological parts do have a big effect. If everyone isn’t motivated, the team ambience is contagious and can cause everyone to become unmotivated.” (participant 1)
	Relationship with fans “It makes me think that I can give hope to them and give them happiness, and I think it really motivates me.” (participant 1)
	Weak management skills “If players fight, the coaches do get involved. They try to get them to make up, and sometimes it works, but most times it doesn’t. When the relationship is beyond repair, the easiest thing the team can do is fire the player from the team.” (participant 4)
	Importance of coaching roles “We know just by the tone of the player’s voice when they are giving orders or briefing someone that they are mad at someone specific. Or that they are angry because they couldn’t pull off a play. We’ve seen it in so many players that it’s easy to catch it. Not just me, but the whole staff.” (participant 4)
Need for intervention	Need sleep enhancement programs “Because most of the players slept through their classes or dropped out of school... it’s better to educate them about sleep with easy content, exposing them repeatedly so they understand the importance of sleep.” (participant 5)
	Need for psychological intervention “Can the players get therapy from someone like in the movies? Once in a while we’ll get a player who really wants therapy.” (participant 4)
	Need to improve communication skills “I feel communication is really really really hard... The reason why there is a problem with communication is that they’re not very good at listening to one another.” (participant 5)
	Need to address emotional problems “They can get angry. Or depressed. You know? I feel they need some hobby to blow off steam or a staff member who can help with these things.” (participant 1)

Sleep Risk Factors

Six sleep risk factors were identified in the interviews with esports athletes. The esports athletes display delayed sleep phases due to their training time, which usually ends very late at night, with one participant reporting “individual training continues until 3 a.m. after completing team training at midnight.” The athletes and their teams insisted that this time frame was necessary to make the training more efficient. In addition, the sleep environment of the shared headquarters, such as the room temperature, outdoor noise, absence of a health management system, use of the wrong methods to improve sleep quality, and time difference due to away matches were also considered sleep risk factors. The interviewees also considered the tension of the night before a competition, long exposure to light, stress, and caffeine-containing drinks as sleep risk factors.

Sleep Protective Factors

Because all the participants from study 1 participated in a sleep education and a feedback session, the effects of those interventions have already been included in the protective factors. Knowledge about the environment that improves sleep quality, proper actions for better sleep quality, and sleep hygiene were identified as protective factors that had a positive effect on sleep quality.

Strategies such as having a more organized lifestyle, improving sleep hygiene, not napping during the daytime, and not using smartphones for more than 30 minutes before going to bed can also improve athletes’ sleep quality.

Stressors

Stress can have a (negative) effect on mental health and sleep quality. Various factors such as fear of the future due to job instability, lack of social support, and competition for the starting line-up (which can cause short-term depression) can cause stress among esports athletes. These factors can cause short-term depression. In addition, personality differences and communication problems with teammates of different nationalities can also cause stress among athletes.

Life of an Esports Athlete

Esports athletes were usually students before they started their careers, with most athletes choosing to drop out of school to become esports athletes. Most of the athletes experienced opposition from their families, but the level of support from their families was dependent on the success of their careers. The majority of the top-tier (popular) athletes had high job satisfaction, and they were proud of their careers. Esports athletes had pride that

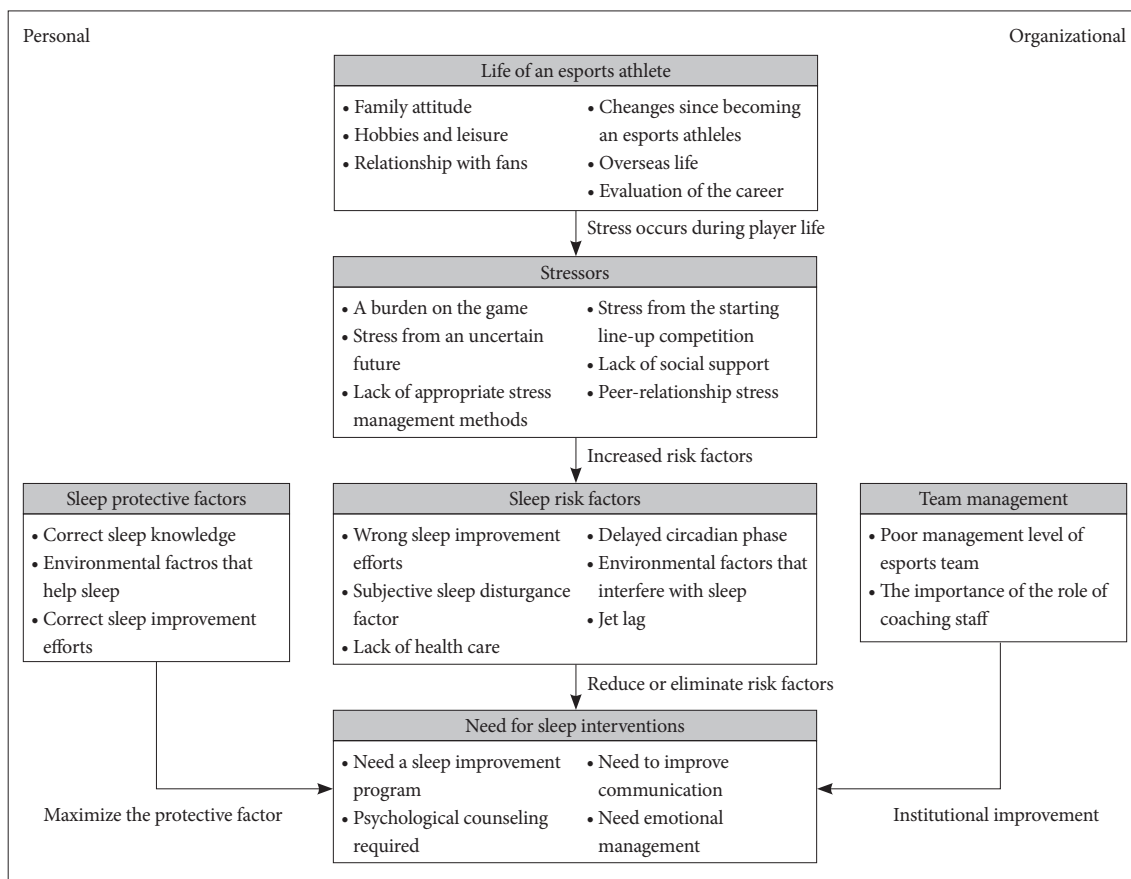


Fig. 1. Structure of sleep and sleep risk factors and life factors of esports athletes.

they had fans and felt responsible for meeting their fans' expectations. In addition, the athletes experienced emotional distress from criticism on social media; furthermore, the atmosphere of the team not only affected the outcome of the game but also the duration of internal team conflicts.

Team Management

Team management was deeply related to both mental health and sleep problems of esports athletes. Few esports teams have an organized management system or a sufficient number of professional managers. Team management seemed to be heavily affected by the head company's capacity and budget. The role of the team directors and coaches who manage young esports athletes is critical. However, they often lack the professional skills to manage the organization, such as managing conflicts between the athletes. Coaches need to be able to help athletes who are having a difficult time with consultation and proper rest and need to teach them how to deal with criticism with a more flexible mindset.

Need for Interventions

The need for intervention was mainly mentioned by the coaches. There were demands for education in communication skills,

emotional management skills, and sleep improvement programs including psychological counseling. Improving awareness of the importance of good sleep has been addressed as the most helpful factor in sleep improvement programs. It was also suggested that educational methods are needed to suit the athletes' learning abilities. For an intervention to be effective, a rather strong level of recommendation is required, and a system that can be enforced may be needed. The esports athletes thought that psychological counseling was essential and felt that it would be helpful to talk to outside experts about topics that were difficult to discuss with their managers, coaches, or teammates. Communication problems within the team were the most frequently mentioned issues by the coaches, and the need for intervention was emphasized. The causes of communication problems appeared to be that most athletes are young, lack sufficient school education, tend to display some self-centered qualities, and do not have sufficient social skills to resolve conflicts.

DISCUSSION

This is the first empirical study to examine sleep in Korean esports athletes compared to nonathletes. The aim of the current

study was to investigate sleep characteristics and sleep risk factors among esports athletes compared with nonathletes. The results from this study indicated that esports athletes had a severely delayed sleep phase compared with their age-matched peers who were nonathletes. While they did not sleep less, esports athletes went to bed an average of more than 1 hour and 40 minutes later than their nonathlete counterparts. The cause of this delayed sleep pattern was explored in study 2 using qualitative methodology.

Sleep Characteristics of Esports Athletes

In this study, the mean TST was 7.26 (\pm 1.21) hours, which was not significantly different from the control group. However, this appears to be significantly lower than mean TSTs of esports athletes in other countries. In previous studies, 8.1 (\pm 1.2) hours sleep in the US [27] and 7.8 (\pm 1.3) hours in Germany [28] were reported. Considering that adolescents in East Asia (especially in Korea) sleep less than those in the US and European countries [29], it is worthy not only to compare them with the general population in Korea but also to esports athletes from other countries.

The delay in sleep phase of esports athletes seems to be primarily affected by their environment and training schedule. Almost every esports athlete lives in shared headquarters with his or her teammates, and they train together. One of the most important parts of team training is practicing matches with other teams (i.e., scrimmage), which makes it difficult to change sleep schedules. In addition, prolonged use of computers for training (and the use of smartphones before bedtime) delays their sleep timing and makes it difficult for athletes to fall asleep at a normal bedtime.

Esports athletes also reported significantly worse sleep quality compared to their nonathlete counterparts. There are two plausible explanations for this difference. First, qualitative evidence from the present study suggests that some esports athletes may be exposed to environmental factors that disturb sleep (e.g., snoring), leading to a deterioration in subjective sleep quality. Evidence indicates that the sleep environment is strongly linked with adequate sleep quality [30]. One noteworthy implication of this finding is that if a team lives in a shared headquarters, as was the case in our study, then presumably an entire team may be at risk of poor sleep quality if the sleep environment is sub-optimal. In addition to sleep environment, poor sleep quality and not feeling refreshed after awakening in the esports athlete group may have been influenced by high levels of depression. Sleep quality is known to be highly correlated with depressive symptoms and stress [31,32]. In this study, the perceived stress level reported by esports athletes was not significantly higher than that of the nonathletes. However, the findings that the average depression score exceeded the clinical cut-off value of 16 and that the rate of the high-risk group for depression reached 64.7% suggests a high possibility that depression worsened the

subjective sleep quality of esports athletes. These high levels of depression are also related to the delayed sleep phase [33]. In a study that examined the relationships among sleep quality, circadian pattern, and emotion in 236 young adults aged approximately 18 years, participants with an evening phase complained of more depressive symptoms [33].

In addition to delayed sleep, our qualitative findings have shown various risk factors for poor sleep in esports athletes. Poor sleep knowledge can act as a perpetuating factor in sleep problems. In the sleep knowledge questionnaire, the average score of the esports athlete group was significantly lower than that of the non-athlete group. Based on misinformation and irrational beliefs, some of the athletes maintained typical persistent behaviors, such as intense training before bedtime [3] or drinking alcohol before bedtime. This suggests that sleep interventions, such as sleep hygiene, may also help improve sleep in this group. In fact, a recent study showed that sleep hygiene education alone helped improve sleep in low socioeconomic groups [34,35].

Interpersonal Factors of Esports Players

Another problem found through qualitative research was the lack of communication skills among the players. Individuals participating in the interviews of the study 2 reported that most esports athletes are young, are not well-educated, and lack sufficient social skills to resolve conflicts. Despite the importance of teamwork and communication skills in this team sport [36], spending long hours without direct personal contact with other individuals outside of the game may result in limited growth of social skills. Insufficient social skills affect not only daily life but also competition performance, and because most of the athletes' time is spent with teammates, their social relationships can have a significant impact on game performance [37]. Furthermore, communication quality may be affected not only by individuals' communication skills but also by their sleep quality. Players with sub-optimal sleep appear more likely to be emotionally sensitive to negative comments from team members and coaches regarding their performance [38]. Stress is itself a risk factor for poor sleep, but a lack of social support, such as that from family and friends, derived from qualitative research is also an important variable to be addressed. Social support is a protective factor that allows individuals to maintain a sense of wellbeing in stressful situations [39]. Even if stress-coping skills are insufficient, mental health can be maintained if social support is sufficient [40].

Organizational and Environmental Factors in Esports Players

The role of the organization is important in reducing the stress of esports players. Our results show that esports athletes' stress levels are greatly influenced by the policies and capabilities of their organizations and managers because they live in a group together. Players mainly reported stress factors such as the bur-

den of the game, anxiety due to an uncertain future, competition for the starting lineup, relationships with their team members, and lack of social support due to camp life. These psychosocial stressors not only reduce sleep quality [41] but can also cause sleep problems [42-45]. In particular, relationships with other team members are often worsened in the course of receiving feedback on the game, which may be the reason that the athletes did not have the opportunity to develop sufficient emotional control skills or social skills, including communication skills. As a result, coaches must intervene in players' conflict situations, but they do not have expertise in conflict mediation or psychological counseling; therefore, the effectiveness of their intervention cannot be guaranteed.

Physical environmental conditions are also directly related to the organization's management capabilities. Sleep hygiene is known to be a protective factor affecting bedtime, sleep latency, and total sleep time [46]. Sleep hygiene is related to several areas of sleep, including behavioral, physiological, and emotional arousal, the sleep environment, and sleep stability [47]. A recent qualitative study on the performance of esports athletes identified a weakness in their emotional regulation ability, lack of trust between peers, and inefficient communication as factors that hinder them from achieving good performance [48]. This is consistent with the qualitative results of this study.

Limitations

This study has some limitations. First, whilst sleep diaries are considered superior to other forms of self-report (e.g., due to reduced memory bias [49]), it would have been valuable to simultaneously obtain objective sleep data (i.e., wrist actigraphy). Second, sufficient quantitative data on risk factors for poor sleep were not collected. Because specific information on predictable factors, such as caffeine use, smoking, and the timing of smartphone use before bedtime, has not been identified, the relationship between these factors and actual sleep was not confirmed statistically. In follow-up studies, the effect size of risk factors for poor sleep could be additionally identified through the collection of detailed information on such life variables.

Conclusion

The current study is the first empirical study to evaluate the sleep of Korean esports athletes. Considering the rapidly growing esports industry, research on the mental health of esports players is crucial. The present study can provide a good reference for future researchers exploring this field. Although it was limited to exploratory research, there are various implications for clinical interventions related to the sleep of esports players. A wide range of interventions including sleep education tailored to the level of esports athletes, cognitive behavioral therapy for insomnia (CBTi), social skills training, emotional management, and stress reduction programs should be developed and implemented on both individual and organizational levels.

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Conflicts of Interest

The authors have no financial conflicts of interest.

Authors' Contribution

Conceptualization: Lee Sangha, Suh S. Data curation: Lee Sangha, Kim Y. Formal analysis: Lee Sangha. Funding acquisition: Suh S. Investigation: Lee Sangha, Kim Y, Suh S. Methodology: Lee Sangha. Project administration: Suh S. Supervision: Suh S, Gradisar M. Validation: Gradisar M, Bonnar D. Visualization: Lee S. Writing—original draft: Lee Sangha, Suh S. Writing—review & editing: Suh S, Bonnar D, Lee Y, Lee Sunkyung.

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