



*Original Research*

## How Long Is Too Long? Effects of Mobile Game Duration on Stress and Cognitive Function by Gender

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### *Abstract*

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Mobile gaming is widely popular among young adults; however, its effects on stress and cognitive function across different play durations and genders remain unclear. This study examined the acute effects of mobile gaming session duration on heart rate (HR), stress, selective attention, and visual short-term memory (VSM) in male and female university students playing Realm of Valor (ROV), a popular multiplayer online battle arena game. Twenty recreational ROV players (10 males, 10 females; aged 20–22 years) completed a randomized crossover trial involving two remotely supervised gaming sessions: three games (~1 hour) and seven games (~3 hours), separated by a 7-day washout period. Participants played in consistent teams from their home environments. HR, stress (Suanprung Stress Test-20), selective attention (Stroop Color and Word Test), and VSM (CogniFit task) were assessed before and after each session using standardized, investigator-monitored protocols. HR increased significantly following both gaming sessions, with no difference between durations. Stress levels increased only after the seven-game session, with females exhibiting greater increases than males. Selective attention improved after three games but not after seven, with greater gains observed in the shorter session. VSM accuracy and response time did not differ significantly between gaming durations. These findings suggest that short-duration mobile gaming may enhance attentional performance with minimal stress, whereas prolonged play increases stress, particularly in females, and diminishes cognitive benefits.

Keywords: Mobile gaming, gender differences, attention, visual short-term memory

### **Introduction**

In the digital age, mobile phones have become indispensable, with individuals spending an average of seven hours daily on their devices. A staggering 92% of this time is spent online.<sup>1</sup> Among younger populations, social media and mobile gaming have surged in popularity,<sup>1,2</sup> with regions such as Thailand, Taiwan, and the United Kingdom reporting particularly high engagement.<sup>2,3</sup>

As mobile gaming expands, gender-related patterns in gaming engagement have been reported, although these differences reflect population-level tendencies rather than fixed preferences. On average, males spend more time gaming and are more frequently represented in action- and

strategy-oriented titles, whereas females are more often associated with puzzle-based or socially oriented games.<sup>4-6</sup> Importantly, contemporary games increasingly integrate overlapping strategic, social, and cooperative elements, resulting in substantial variability in player roles, communication demands, and cognitive requirements across titles and genres. Women are also less likely to self-identify as gamers or participate in competitive online environments compared to men.<sup>7</sup> These disparities raise important questions about how gender may shape the psychophysiological and cognitive impacts of mobile gaming.

Multiplayer online battle arena (MOBA) games, such as *Realm of Valor (ROV)*, illustrate the rising popularity of competitive mobile Esports.<sup>8</sup> A typical ROV match lasts ~20 minutes, with players often completing multiple games per session, totaling an hour or more.<sup>9</sup> While popular, extended play has raised concerns about sedentary behavior and related health risks.<sup>3,10-12</sup> Conversely, moderate gaming may provide benefits, as playing for < 1.5 hours daily has been linked to improved well-being.<sup>13</sup>

Although *League of Legends (LoL)* is widely used in Esports research, ROV was selected for this investigation due to its substantially higher popularity and daily user engagement among university-aged players in Southeast Asia, particularly Thailand.<sup>14</sup> ROV provides a more ecologically valid platform for examining typical gaming behavior in this population. Importantly, ROV shares core structural features with LoL, including 5v5 competitive team play, lane-based strategy, and specialized roles such as Tank, Jungler, Mid-laner, Marksman, and Support, along with comparable communication and coordination demands. These similarities ensure that psychophysiological and cognitive outcomes measured in ROV closely parallel those reported in LoL research while maintaining cultural and behavioral relevance for our sample.

From an exercise science perspective, Esports shares features with physical activity in terms of duration, intensity, and performance demands. Competitive play provokes measurable psychophysiological responses, including elevated heart rate, blood pressure, and autonomic changes, during both laboratory tasks and live tournaments.<sup>15,16</sup> Energy expenditure during gameplay exceeds resting levels, though it typically falls within light-intensity ranges.<sup>17</sup> In terms of cognitive outcomes, short bouts of play have been shown to acutely enhance executive function and attentional control,<sup>18</sup> whereas prolonged gaming sessions induce measurable cognitive decline and heightened mental fatigue.<sup>19</sup> In addition to attentional control, visual short-term memory (VSM) is a critical cognitive component in mobile Esports, as players must rapidly encode, retain, and update visual information such as minimap cues, opponent positions, and dynamic interface elements during MOBA gameplay. These patterns parallel exercise responses, where moderate activity can facilitate performance, while overexertion produces fatigue and diminished efficiency. Unlike traditional exercise, however, Esports lacks musculoskeletal and cardiovascular loading, limiting its physical health benefits. Still, it serves as a valuable model for studying psychophysiological adaptation and cognitive fatigue under competitive conditions. These parallels strengthen the case for examining Esports within kinesiology and exercise science, as both fields aim to optimize human performance and health.

Building on this perspective, the present study investigates the immediate effects of one-hour (three games) and three-hour (seven games) ROV sessions on HR, stress, selective attention, and VSM in male and female university students. By situating mobile gaming outcomes within exercise science frameworks, we aim to clarify how session duration and gender influence psychophysiological and cognitive responses in ways analogous to exercise-induced stress, fatigue,

and recovery. We hypothesized that (1) shorter gaming duration (one hour) would be associated with lower stress responses and greater improvements in selective attention compared with prolonged gaming (three hours); (2) prolonged gaming would elicit higher stress and cognitive fatigue; and (3) stress responses would differ by gender, with females exhibiting greater stress increases following extended play. Recognizing these dynamics is particularly important given the rapid rise of Esports worldwide, especially among students, where appropriate engagement may help reduce sedentary inactivity, while pairing gaming with structured physical exercise could optimize both cognitive and physical health outcomes.

## **Methods**

### *Participants*

This study employed a randomized crossover design, with the sample size calculated using G\*Power 3.1.9.2, based on a previous study.<sup>20</sup> An effect size of  $f = 0.4$ , an alpha level of 0.05, and a power of 0.85 indicated a required sample size of 20 participants, allowing for a 10% dropout rate.

A total of 20 healthy university students (10 males and 10 females), aged 20 to 22 years, were recruited from second- and third-year students at the College of Sports, Mahidol University. Participants were selected based on their regular gaming habits, defined as playing *Realm of Valor* approximately 2–3 times per week for at least one hour per session for a minimum of 6 months prior to study enrollment. This criterion was chosen to ensure adequate familiarity with gameplay mechanics while avoiding characteristics of highly trained or competitive Esports athletes, consistent with prior Esports and gaming research.<sup>21</sup> Participants were required to be free from any musculoskeletal injuries within the previous six months that could affect gameplay performance or posture. Individuals with uncorrected visual impairments were excluded; only participants with normal or corrected-to-normal vision (e.g., contact lenses or corrective eyewear) were eligible for inclusion.

Exclusion criteria also included any underlying conditions such as ADHD, schizophrenia, or vision/hearing impairments, as well as the use of medications like antidepressants or Ritalin. Informed consent was obtained from all participants, and the study was approved by the Human Experimentation Ethics Committee of xxx University (xx-xxxx xxxx/xxx.xxxx), adhering to the 2013 Declaration of Helsinki and the ethical standards of the International Journal of Exercise Science.<sup>22</sup>

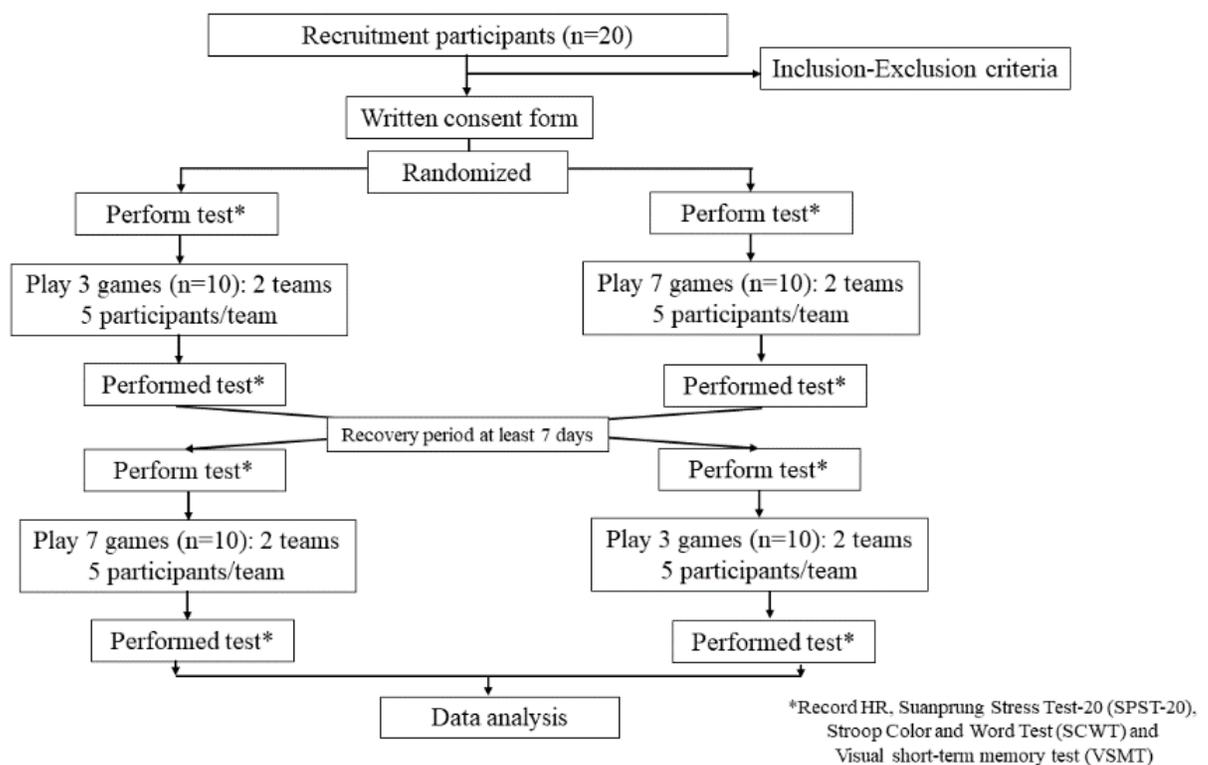
### *Protocol*

Figure 1 outlines the experimental design. Participants first completed a demographic questionnaire, covering body weight, height, medical history, and gaming habits.

On the day prior to testing, participants were instructed to follow strict guidelines, including getting 6–8 hours of sleep, abstaining from caffeine for 12 hours, and avoiding medications that might affect their nervous system. Data collection was conducted remotely, with participants using their personal gaming setups. Resting heart rate (HR) was recorded at 3:00 p.m. using the Apple Watch (AW) Series 2, chosen for its reliability and high correlation coefficient.<sup>23</sup> In this investigation, the AW Series 2 was chosen due to evidence demonstrating that it provides heart rate values comparable to those obtained from validated research-grade devices such as the ActiGraph.<sup>24</sup>

Prior to baseline HR assessment, participants were instructed to sit quietly in a comfortable seated position for 10 minutes, refrain from speaking or interacting with electronic devices, and maintain normal breathing to approximate a physiological resting state. Resting HR was recorded immediately before gameplay. Post-gaming HR was recorded immediately following completion of each gaming session. HR values were obtained directly from the device display at these predefined time points and documented by the investigators.

Participants completed the Suanprung Stress Test-20 (SPST-20), Stroop Color and Word Test (SCWT), and Visual Short-Term Memory Test (VSMT) online before and after each gaming session. Participants were then randomly assigned to one of four teams using a gender-specific format, such that male participants competed exclusively in male-only teams and female participants competed exclusively in female-only teams. Each team consisted of five players (5v5), and teams remained consistent across the three-game and seven-game conditions to control for variability in team dynamics and communication patterns. Participants played either three or seven games of ROV. After each session, HR, stress levels, cognitive performance, and VSM were reassessed.



**Figure 1.** Experimental procedure.

ROV is a free-to-download mobile MOBA game designed for smartphone and tablet platforms, in which players assume specialized roles with unique abilities and engage in competitive 5v5 team-based play within structured arenas.<sup>25</sup> The game incorporates Voice over Internet Protocol (VoIP) to facilitate real-time team communication during gameplay.<sup>26</sup> All gameplay sessions were conducted using participants' personal mobile devices to preserve ecological validity and reflect habitual gaming behavior. At the time of data collection, participants used the most current publicly available version of ROV, which is routinely updated by the developer. Device model and operating system were not standardized, however, all participants reported prior familiarity with their devices and stable gameplay performance.

The SPST-20 is widely used in Thailand to assess chronic stress over extended periods and was selected for this study due to its relevance and familiarity within the target population. Although the instrument primarily reflects long-term stress, we acknowledge its limitation in capturing acute stress responses. The questionnaire consists of 20 items rated on a 5-point Likert scale (0–5), providing an overall measure of perceived stress.<sup>27,28</sup> Items assess both psychological and somatic manifestations of stress, including feelings of anxiety, irritability, confusion, fatigue, and physical discomfort (e.g., headaches or muscle tension). The SPST-20 demonstrates acceptable reliability and validity, with a reported Cronbach's alpha of 0.70.<sup>27</sup> Participants completed the questionnaire online, with an investigator available for assistance if needed. Cumulative scores from all 20 items (overall range: 0–100) were used to categorize stress levels as follows: 0–23 points indicate low stress; 24–41 points indicate moderate stress; 42–62 points indicate high stress; and >63 points indicate severe stress.

The SCWT assesses multiple cognitive functions, including attention and processing speed. The SCWT demonstrates acceptable reliability with a coefficient of 0.67.<sup>29</sup> The online version of the SCWT, administered via the Free Brain Age platform, has been employed in prior research and incorporates randomized stimulus presentation across trials to minimize order and practice effects. Participants were required to identify the ink color of words as quickly as possible (e.g., the word “red” displayed in green ink). The SCWT was administered for 5 minutes, and total scores at completion were used for analysis.

The VSMT is a neuropsychological assessment that measures the ability to temporarily retain visual information.<sup>30</sup> The VSMT has high reliability and validity, with a Cronbach's alpha of 0.76.<sup>31</sup> An online version of the VSMT was administered using the CogniFit platform, which employs randomized sequences of visual stimuli across trials and sessions to reduce learning effects and enhance internal validity. The test offered either animal or natural images; participants completed the animal-picture version during the three-game condition and the nature-picture version during the seven-game condition. Participants were instructed to memorize images presented in random order and select previously displayed images as quickly and accurately as possible. The test duration was 5 minutes. Response time (milliseconds) and percentage of errors were recorded for analysis.

### *Statistical Analysis*

The data were analyzed using a mixed-model analysis of variance (ANOVA), with condition (three games vs. seven games) and time (pre- vs. post-play) specified as within-subject factors, and gender (male vs. female) specified as a between-subject factor. The Shapiro–Wilk test was used to confirm normality, and Mauchly's test of sphericity was applied where appropriate. When the assumption of sphericity was violated, Greenhouse–Geisser corrections were applied. Partial eta squared ( $\eta^2$ ) was reported as the measure of effect size for all ANOVA effects and interpreted as small (0.01), medium (0.06), or large (0.14).

Percentage changes (% $\Delta$ ) from pre- to post-gaming were calculated for heart rate, stress scores, Stroop performance, and visual short-term memory outcomes. These % $\Delta$  values were used for two purposes: (1) mean comparisons between the three-game and seven-game conditions using paired t-tests with Bonferroni correction, and (2) correlational analyses examining associations between % $\Delta$  stress scores and gender. Cohen's d was calculated to quantify the magnitude of differences between gaming conditions and interpreted as small (0.2), medium (0.5), or large (0.8).

Pearson's correlation coefficient ( $r$ ) was used to assess the strength and direction of relationships between  $\% \Delta$  stress scores and gender, with  $r^2$  values reported to indicate the proportion of variance explained. Correlation analyses were conducted separately for the three-game and seven-game conditions.

A significance level of  $p < 0.05$  was used for all statistical tests. Effect sizes (Cohen's  $d$ ) and 95% confidence intervals (CIs) were reported alongside all pairwise comparisons. All statistical analyses were conducted using SPSS software version 20. Participant characteristics are presented as means  $\pm$  SD to describe sample variability, whereas outcome measures are presented as means  $\pm$  SEM to illustrate precision of estimated effects.

## Results

The general characteristics of the participants and their gaming behavior are summarized in Table 1

**Table 1.** Participant's characteristics. The data are presented as means  $\pm$  SD ( $n = 20$ ).

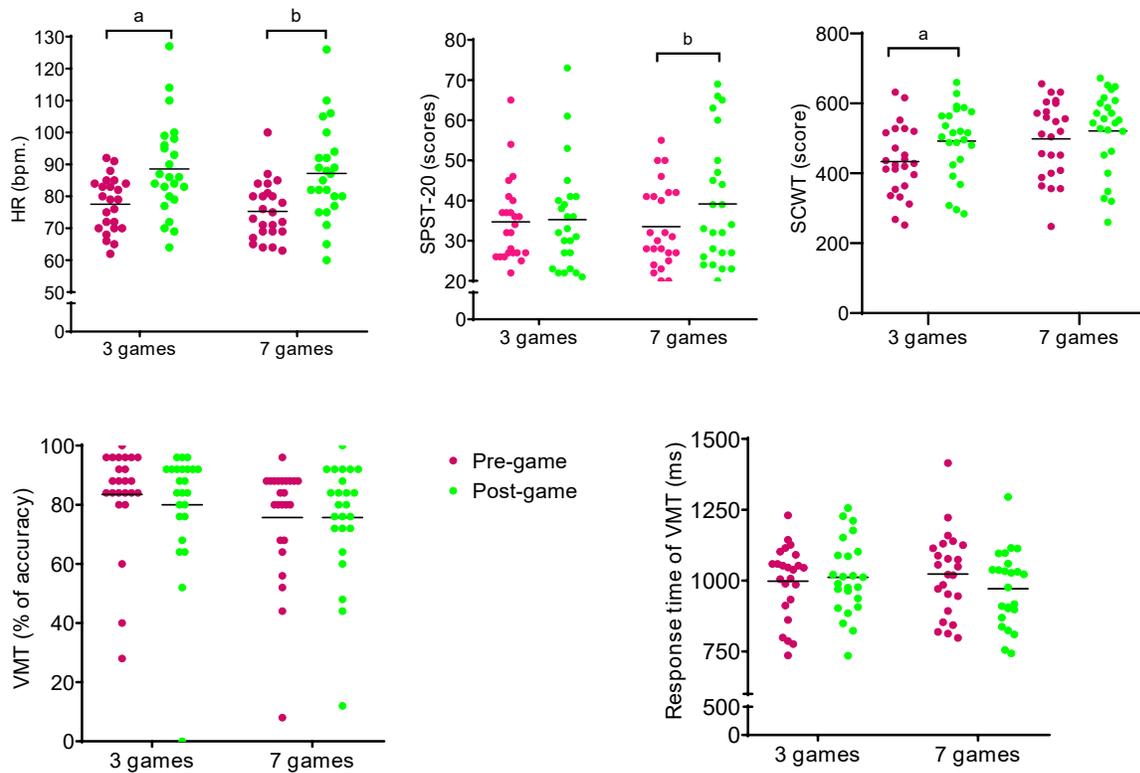
Variables	Total	Males	Females
Age (years)	21 $\pm$ 0.6	21 $\pm$ 0.6	21 $\pm$ 0.7
Sex (males: females)	20	10	10
Body weight (kilograms)	64 $\pm$ 12	70 $\pm$ 11	57 $\pm$ 8
Height (centimeters)	170 $\pm$ 9	175 $\pm$ 8	165 $\pm$ 8
BMI (kilogram/meter <sup>2</sup> )	22.0 $\pm$ 3.0	21.1 $\pm$ 2.8	22.9 $\pm$ 3.1
Resting heart rate (beats per minute)	75 $\pm$ 9	74 $\pm$ 8	75 $\pm$ 9
Time spent using electronic devices per day (hours)	7 $\pm$ 1		
Time spent playing for 3 games (minutes)	50 $\pm$ 15		
Time spent playing for 7 games (minutes)	160 $\pm$ 20		

A significant effect of time (pre vs. post) on HR was observed ( $F(1, 46) = 28.27$ ,  $\eta^2 = 0.38$ ,  $p < 0.001$ ), with HR increasing by 11 beats per minute (bpm) after three games ( $p = 0.001$ ) and by 12 bpm after seven games ( $p = 0.001$ ) (Figure 2). However, the duration of gaming (three vs. seven games) did not significantly affect HR ( $F(1, 46) = 0.44$ ,  $\eta^2 = 0.02$ ,  $p = 0.51$ ), as the percentage increase in HR was similar across both conditions (three games: 14%, seven games: 16%; Table 2). Both males and females experienced significant increases in HR after gaming, with no significant differences between genders (Table 3).

**Table 2.** Comparing percentage changes ( $\% \Delta$ ) of heart rate (HR), Suanprung Stress Test-20 (SPST-20), Stroop Color and Word Test (SCWT), and visual short-term memory test (VSMT) between the three-game condition (3 games) and the seven-game condition (7 games). Data are presented as means  $\pm$  SEM;  $n=20$ .

$\% \Delta$	3 games	7 games	t	Cohen's D	95%CI	p-value
HR (%)	14 $\pm$ 4	16 $\pm$ 4	0.30	0.79	-9.68 to 13.0	0.38
SPST-20 (%)	2 $\pm$ 6	17 $\pm$ 8	1.47	0.37	-5.53 to 35.7	0.07
SCWT (%)	14 $\pm$ 4	5 $\pm$ 3	1.88	0.09	-18.6 to 0.63	0.03*
VSMT (%)						
- Percentage of accuracy	-4 $\pm$ 4	0 $\pm$ 4	0.72	0.73	-7.48 to 15.8	0.24
- Response time	1 $\pm$ 3	-5 $\pm$ 3	1.66	0.79	-14.3 to 1.4	0.05

\*, significant between playing 3 games and 7 games.



**Figure 2.** Individual data and means of heart rate (HR), Suanprung Stress Test-20 (SPST-20), Stroop Color and Word Test (SCWT), and visual short-term memory test (VMT) at pre- and post-playing 3 games and 7 games. n=20. bpm = beat per minute; <sup>a</sup>, significant between pre-and post-playing 3 games; <sup>b</sup>, significant between pre-and post-playing 7 games.

**Table 3.** Heart rate (HR), Suanprung Stress Test-20 (SPST-20), Stroop Color and Word Test (SCWT), and visual short-term memory test (VSMT) at pre- and post-playing 3 games and 7 games in females and males. Data are presented as means ± SEM; n=20 for the total.

Variable	3 games		7 games	
	Female	Male	Female	Male
HR (bpm)				
Pre-game	78±2	77±3	73±3	74±2
Post-game	90±3 <sup>a</sup>	90±5 <sup>a</sup>	87±5 <sup>b</sup>	88±5 <sup>b</sup>
SPST-20 (scores)				
Pre-game	37±4	30±2	36±3	31±4
Post-game	40±5	29±2	45±5*	31±3
SCWT (scores)				
Pre-game	461±20	431±36	465±26	515±43
Post-game	489±36	493±26	515±35	541±39
VSMT				
- Percentage of accuracy				
Pre-game	89±2	81±7	79±4	74±8
Post-game	84±4	75±9	74±4	75±9
- Response time (ms)				
Pre-game	1035±35	976±55	1064±50	952±39
Post-game	1016±38	991±49	983±38	935±55

bpm = beats per minute, ms =millisecond. <sup>a</sup>, significant between pre-and post-playing 3 games; <sup>b</sup>, significant between pre-and post-playing 7 games; \*, significant between females and males at post-7 games.

Stress levels, as measured by the SPST-20, showed a significant increase after the seven-game session compared to baseline ( $F(1, 46) = 5.11, \eta^2 = 0.12, p = 0.03$ ), whereas no significant changes were observed after three games ( $p > 0.05$ ). Although stress levels were higher after seven games, this difference between the three- and seven-game sessions did not reach statistical significance ( $F(1, 46) = 0.84, \eta^2 = 0.06, p = 0.36$ ). Stress scores did not differ significantly between the three-game and seven-game conditions ( $p > 0.05$ ; Table 2). Gender differences were pronounced, with females showing a significantly greater increase in stress levels after seven games compared to males ( $p = 0.01$ ; Table 3). A significant correlation was found between the percentage change in stress scores and gender in the seven-game condition ( $r^2 = 0.17, p = 0.04$ ; Table 4).

**Table 4.** Pearson correlations between baseline to post-percentage changes (% $\Delta$ ) of stress score in the three and seven-game condition and gender ( $n = 20$ ).

	% $\Delta$ of stress score					
	3 games		7 games			
	$r$	$r^2$	$p$	$r$	$r^2$	$p$
Gender	-0.1921	0.3691	0.20	-0.4070	0.1657	0.04*

\*,  $p < 0.05$ .

Cognitive performance, as measured by SCWT scores, improved significantly after three games ( $F(1, 46) = 14.00, \eta^2 = 0.23, p = 0.001$ ), but no significant changes were observed after seven games ( $p = 0.29$ ). The three-game session led to a greater improvement in SCWT scores compared to the seven-game session (three games: 14%, seven games: 5%,  $p = 0.03$ ; Table 2). There were no significant gender differences in SCWT scores for either gaming condition (Table 3).

No significant differences were observed in VSM accuracy or response times between the three-game and seven-game sessions ( $p > 0.05$ ; Figure 2 and Table 2). Gender did not significantly influence VSM performance in either condition (Table 3).

## Discussion

This study investigated the acute effects of different durations of mobile game playing on HR, stress levels, cognition, and VSM in male and female university students. The findings reveal important insights into the physiological and cognitive impacts of mobile gaming, particularly the influence of game duration and gender.

Both the three-game (~1 hour) and seven-game (~3 hours) sessions led to significant increases in HR, consistent with previous research showing elevated physiological arousal during competitive gaming.<sup>16</sup> However, there was no significant difference in the magnitude of HR increases between the two conditions, suggesting that once a certain level of engagement is reached, further game duration does not significantly amplify HR responses. This aligns with studies suggesting that the excitement and competition inherent in multiplayer games like ROV activate the autonomic nervous system, triggering HR increases.<sup>32,33</sup> Notably, HR responses were similar across genders, indicating that both males and females experience comparable levels of physiological arousal during gameplay.

In contrast, stress levels, as measured by the SPST-20, were significantly higher after the seven-game session compared to the three-game session, with a notable gender difference. Females exhibited a greater increase in stress following prolonged gaming, which may reflect differences in stress appraisal or familiarity with competitive gaming contexts. Previous research suggests that females are less likely to engage in competitive action games like ROV, which may make

the experience more stressful.<sup>34</sup> In fact, females tend to prefer puzzle or social simulation games more than males,<sup>4,6</sup> which may explain why females are more likely to exhibit a stress response to gaming.<sup>35</sup> The significant correlation between gender and stress levels in the seven-game condition supports this, highlighting the need for further exploration of how gaming preferences and experiences differ across genders.

Cognitive performance, as assessed by SCWT scores, showed significant improvement after the three-game session, while no notable changes were observed following the seven-game session. This suggests that shorter gaming durations may enhance cognitive function, potentially due to the stimulating nature of competitive gameplay, which engages executive functions like decision-making and attentional control.<sup>36</sup> In contrast, prolonged gaming could lead to cognitive fatigue, diminishing the benefits that shorter sessions provide. These findings align with studies showing that moderate gaming can improve specific cognitive processes, particularly attention and processing speed,<sup>37,38</sup> while extended sessions may have a less pronounced impact on these abilities. The lack of significant gender differences in SCWT scores suggests that both males and females benefit similarly from shorter gaming sessions in terms of cognitive performance. However, the reduced cognitive benefits after seven games highlight the potential for gaming duration to influence cognitive outcomes, with longer sessions potentially leading to diminished returns.

VSM is the capacity of a human to hold a limited amount of visual information for a short period.<sup>30</sup> In contrast to HR and cognitive performance, VSM accuracy and response times were not significantly affected by either gaming duration. This finding differs from previous studies that have reported improvements in VSM among action video game players.<sup>37-39</sup> Additionally, the study done by Wilms et al.<sup>39</sup> measured the effect of action video gaming on VSM in 3 groups: non-players (< 2 h/month), casual players (4-8 h/month), and experienced players (> 15 h/month), indicated an improvement in encoding speed to VSM which seems to depend on the time devoted to gaming. One possible explanation is that the participants in this study were recreational gamers rather than experienced or frequent players, which may limit the transfer of gaming-related benefits to VSM. Additionally, the relatively short gaming sessions (three to seven games) may not have been long enough to induce measurable changes in VSM.

From an exercise science perspective, these findings parallel responses observed in traditional physical activity: shorter bouts provide performance-enhancing effects similar to warm-up, while extended sessions mirror the fatigue and stress associated with overtraining. This conceptual alignment underscores the value of Esports as a model for studying psychophysiological adaptation, stress regulation, and cognitive workload within kinesiology.

The present study highlights several important considerations for mobile gaming. First, while gaming can elevate HR and stress levels, particularly after prolonged sessions, shorter gaming durations may offer cognitive benefits without significantly increasing stress. This reinforces the idea that session duration is a critical factor influencing whether Esports resembles beneficial moderate-intensity exertion or potentially harmful overload. The observed gender differences in stress responses suggest that tailored recommendations for gaming duration based on gender may be beneficial, especially for female gamers who may experience higher stress during longer gaming sessions. Further research is needed to explore the long-term effects of mobile gaming, particularly with regard to stress and cognitive function. Future studies should also investigate the impact of different game genres and difficulty levels, as these factors may differentially affect physiological and cognitive outcomes. Additionally, exploring the underlying mechanisms

behind the gender differences observed in stress responses could provide valuable insights for developing more inclusive and balanced gaming environments.

This study has several limitations that should be acknowledged. First, although the sample size was sufficient to detect the primary effects based on a priori power analysis, the relatively homogeneous sample of university students and recreational gamers may limit the generalizability of the findings, particularly with respect to gender-related differences in stress responses across broader Esports populations. Second, the use of the SPST-20, which is primarily designed to assess chronic stress, may not fully capture acute stress fluctuations associated with short-term gaming sessions. Third, while heart rate was measured, additional exercise-science markers such as heart rate variability, salivary cortisol, or electrodermal activity would provide more comprehensive insight into acute stress physiology. Fourth, role-specific demands inherent to MOBA games were not controlled. Different in-game roles (e.g., jungler, laner, support, marksman) vary substantially in attentional load, decision-making frequency, and communication demands, which may influence both cognitive workload and stress responses. Future studies should consider stratifying or controlling for player roles to better isolate role-dependent and cross-game experience psychophysiological effects. In addition, data on participants' preferred in-game roles and their engagement with other video games were not collected. Experience with different game genres and platforms may influence stress reactivity, attentional demands, and strategic decision-making during gameplay. Future studies should systematically document players' primary roles and broader gaming histories to better account for these potential confounding factors. Finally, gameplay was conducted remotely using participants' personal devices and internet connections, introducing potential variability related to device performance (e.g., screen size, processing speed) and network latency. Such factors may influence reaction time, gameplay fluidity, and perceived stress during competitive play. Although this approach enhanced ecological validity, future laboratory-controlled studies should standardize hardware and network conditions to reduce these sources of variability.

This study demonstrated that gaming duration influences stress levels and cognitive performance in university students. Both short (one-hour) and long (three-hour) gaming sessions increased heart rate, but stress levels were significantly higher after longer sessions, especially among females. Shorter sessions improved cognitive performance, while extended play led to cognitive fatigue, diminishing these benefits. Visual short-term memory was unaffected by gaming duration. These findings suggest that shorter gaming sessions can enhance cognitive function with minimal stress, while longer sessions may increase stress, particularly for female players. Tailoring gaming habits to session length and individual differences, while combining structured exercise with gaming, may optimize both cognitive and physical health outcomes.

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