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Esport: Fortnite Acutely Increases Heart Rate of Young Men

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ABSTRACT

International Journal of Exercise Science 13(6): 1217-1227, 2020. Esports has rapidly increased in online play and viewing. A myriad of literature focuses on heart rate (HR) during traditional athletic competition, little research has addressed the HR responses of individuals playing esports and none in the esport: Fortnite. The purpose of this study was to compare the HR response during a 3-hour seated session of the esport: Fortnite to resting HR. Male college students (n = 23; age = 21 ± 1.8 years; BMI = 25.7 ± 3.9; Esport mean hours per week = 13 ± 8.7) were recruited to participate in the study. Mean and peak resting HR were collected during two HR measurements in a controlled laboratory setting. Additionally, participants wore the HR monitor to record mean and peak HR during their regular 3-hour esport: Fortnite session at home. Participants were also instructed to record their match statistics from each solo round. Separate paired sample t-tests were conducted to compare mean resting heart rate (rHR) vs. mean seated esport heart rate (eHR) and peak rHR vs. peak eHR. Pearson's r correlations were used to investigate relationships between variables. There was a statistically significant increase in mean eHR compared to mean rHR (76 ± 10 bpm vs. 70 ± 11 bpm; $p < 0.05$) and peak eHR compared to peak rHR (120 ± 16 bpm vs. 81 ± 11 bpm; $p < 0.05$). The average number of kills was 29 ± 18.6. This initial study suggests esport: Fortnite increases individuals seated HR, suggesting a physiological stressful event.

KEY WORDS: Video games, cardiovascular, competitive, gaming, stress, physiology, exercise.

INTRODUCTION

Esports, or competitive video gaming, has rapidly increased in online play and viewing, becoming a significant part of modern sports culture. The International Olympic Committee has acknowledged that esport is plausibly a sporting activity (27). Regardless of whether esports should be considered sports or not, the growth of esports is not limited to the increase in the number of players. The number of viewers and revenue generated continues to grow each year. In 2018, the total video game sales exceeded $43.4 billion as over 164 million adults in the United States play video games and 75% of American homes have at least one gamer (6). Revenues from esports competitions (sponsorship, media rights, advertising, merchandise and tickets, and game publisher fees) are expected to reach $1.1 billion in 2019; with the year-on-year growth of over 26.7% (18). Esports global audience is also estimated to grow to 453.8 million of viewers in 2019 and is expected reach 1.1 billion viewers per year in 2021 (18). The growth of esports has led to an increase in prize money for esports tournaments. For example, the highest-earning e-athlete in 2018 made $2,290,631 only with tournament prizes (7). Additionally, League of Legends reached its peak revenue per year in 2017 with $2.1 billion being generated (12). Fortnite, a free-to-play game created by Epic Games, has gained rapid popularity while generating over $2.4 billion in 2018 (most from in-game purchases) with over 200 million players worldwide (26). Recently, the Battle Royale Solo mode winner of the 2019 Fortnite World Cup, a 16 years old male, earned the largest-ever payout (3 million dollars) for a single player in an esports tournament (15).

However, despite the growth, the physiological demands of esports and the amount of physical activity performed by e-athletes have not been heavily researched. In a survey of high-level e-athletes, it was observed that 88.7% exercise regularly (13). The average hours of overall training were 5.28 (esports, mental, and exercise) per day including 1.08 daily hours of physical exercise (13). Conversely, in a more recent survey, DiFrancisco-Donoghue et al. (5) reported that 40% of collegiate esports players do not participate in any form of physical activity. Additionally, a myriad of literature has examined heart rate (HR) responses to traditional athletic competition including soccer, basketball, cricket, volleyball, handball (3, 4, 16, 19, 21, 24, 29) and exergames (motion-based video games) (1, 10). However, research has not extensively addressed the physiological responses of individuals competing in esports.

In a non-competitive environment, violent video games have increased individuals perceived stress levels, systolic blood pressure, and HR comparatively to watching non-violent television (22, 23). Interestingly, elevated heart rates have been observed immediately prior to the start and during a chess match (28). Suggesting that the elevated HR could indicate an anticipatory stress response to competition even when physical activity is not demanded (28). Currently, to the authors' knowledge, only one (non peer-reviewed) study has examined the HR response during an esports: League of Legends tournament (>30 minutes) observing peak HR of 160-180 bpm (9). Further, serum cortisol was examined observing spikes "comparable to what is observed in race car drivers" (9). However, complete data from this study performed in the German Sport University could not be found and assumptions should not be made by these results alone. Additionally, when examining hormonal markers (testosterone, cortisol, and DHEA) in an esports: League of Legends college team practice, no statistically significant alterations were noted (11). However, correlations did exist between the time (15-27 minutes) spent playing and changes in these markers, suggesting a potential dose-response relationship (11). Thus, longer playing durations could potentially elicit a greater physiological response from esports players. Given the lack of data and previous reports, there is justification to explore the potential physiological responses to this new paradigm. Understanding the physiological response to esports is critical to better prepare e-athletes for competition, to provide the base for additional investigations, and especially for exercise prescription to potentially blunt the physiological stress during competition. Moreover, to date there is no research in this realm of esports: Fortnite.

Therefore, the purpose of this investigation is to compare the HR response during a 3-hour seated session of the esport: Fortnite to resting HR. Secondary aims of this study were to analyze possible relationships among demographics, gaming performance, and physiological data. We hypothesized that peak and average HR would be elevated while playing Fortnite compared to resting HR.

METHODS

Participants

After obtaining Institutional Review Board Approval from the University of Mississippi, a total of twenty-four (24) male college students (21 ± 1.8 years) were recruited from around the University of Mississippi and from the Ole Miss Esports Club team. Recruitment techniques were performed equally for both genders. Nonetheless, all twenty-four participants recruited were males. Additionally, all experimental procedures involved in the study conformed to the ethical consideration of the Helsinki Declaration. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (17). An a-priori power analysis was conducted with G*POWER 3.1 (Universitat Kiel, Germany). Based on reported means and standard deviations (SD) from a previous study (10) using a two-tailed test with an effect size d of 0.86 and alpha error probability of 0.05, 13 participants were needed to have an achieved power (1-beta error probability) of 0.80 to detect differences in the heart rate of gamers. Eligibility was limited to individuals between the ages 18 to 30 years old who played at least 6 hours or more of esports per week for at least the previous 6 months. Participants who were taking medications known to influence the cardiac or endocrine systems (e.g., blood pressure, HR, thyroid, etc.) were excluded from the study. Data was collected in the fall of 2018 during the months of October-December. After an initial review of eligibility criteria, participants signed informed consent forms prior to participating in the study. A total of 24 esports players of various levels were enrolled in the study (regular players to collegiate competitors). Twenty-three participants completed the study and one individual was dropped for failure to adhere to the protocol. Data on the variables of interest were only missing for the one participant that did not adhere to the protocol. Therefore, data analyses (Person r correlations and paired samples t-tests) were conducted using a sample size of 23 participants.

Table 1. Participant Demographics (n = 23).

Variables	Mean ± Standard Deviation	Minimum	Maximum
Age, years	21 ± 1.8	18	26
BMI, $kg.m^{-2}$	25.7 ± 3.9	18.1	33.5
Height, cm	182 ± 7.2	170	193
Weight, kg	85.2 ± 14.1	61.2	111.1
Hours of exercise per week	6 ± 4.3	0	20
Days of exercise per week	4 ± 1.4	0	6
Hours of esports per week	13 ± 8.7	6	40

Protocol

Two study visits were required to complete the study. Prior to the visits, participants were instructed to refrain from ingesting caffeine, smoking, and drinking alcoholic beverages for at least 12 hours. During the initial visit, participants arrived to the lab to complete the health, exercise, and esports training history forms. These questionnaires included questions such as: "How many days per week do you exercise? How many hours per week do you exercise? How many hours per week do you play esports?" Should they qualify to participate, height and weight were reported by the participants as a study descriptive.

Although height and weight were self-reported, this type of data can accurately identify overweight/obesity in young adults (2). Therefore, the BMI data reported here may only provide information regarding the Body mass index (BMI) classification of the participants rather than the BMI number per se. BMI was calculated using height and weight reported by the participants (BMI = kg/m^2).

Participants rested seated for ten minutes to ensure resting status prior to a 15-minute seated resting HR measurement collected using a Polar H10 HR monitor (Polar Electro; Stamford, Conn.) connected via Bluetooth to the Polar Beat phone application. The length of the resting HR measurement was chosen in accordance to Graves et al. (10). Heart rate was measured continuously in 5-s intervals. The participants were then given verbal instructions and a demonstration on how to connect the HR monitor. Participants wore the HR monitor during their regular 3-hour Fortnite training session that day (seated during entire session) at their homes while recording each match statistics (number of matches, wins, kills, and place per match).

Instructions for the Fortnite session were as follows: a) refrain from ingesting caffeine for twelve (12) hours prior to the Fortnite session; b) begin recording esports heart rate (eHR) immediately prior to starting a session; c) be seated at all times while playing; d) record match statistics for each match before continuing to the next match; e) eat and use the restroom before playing to avoid interruptions.

Upon completion of the esport: Fortnite (Battle Royale solo mode) 3-hour session, participants returned to the lab within 24-hours. During the second visit, participants reported their match statistics and seated compliance to the research team. Similarly, to the first visit, participants rested seated for ten minutes to ensure resting status prior to a 15-minute seated resting HR to complete the study. As an attempt to ensure the validity of the resting HR values, the average resting heart rate (rHR) was calculated using resting HR values from both resting measurements. The mean and peak values reported for each session by the Polar Beat application were used in all the HR measurements.

Statistical Analysis

Paired samples t-tests were utilized to compare mean rHR to mean eHR and for peak rHR to peak eHR. Independent samples t-test was utilized to compare the hours of esports per week of individuals in underweight/normal and overweight/obese BMI ranges. An intra-class correlation (ICC) was performed to determine the reliability of the two resting HR measurements. ICC values lower than 0.5 are indicative of poor reliability, values between 0.5 and 0.75 indicate moderate reliability, values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability. Pearson product-moment correlation coefficients were calculated for assessing the relationships among BMI, mean rHR, mean eHR, peak rHR, peak eHR, wins, kills, average kills per game, hours of esports per week, and hours of exercise per week. The magnitude or the strength of the associations were considered very weak if Pearson's r values were between 0-0.19, weak if between 0.2-0.39, moderate if between 0.4-0.59, strong if between 0.6-0.79, and very strong if between 0.8-1. To examine for normality of data, the Shapiro-Wilk test of normality was utilized prior to data analysis. Logarithmic transformations were applied to the non-normal variables when necessary. Statistical analyses were performed using SPSS 25 software (IBM, Chicago, IL) and JASP (version 0.9.2, University of Amsterdam, NL), and an alpha of 0.05 was adopted throughout. Results were considered statistically significant if p-value < 0.05.

RESULTS

Participant demographics are reported in Table 1. Figure 1 shows statistically significant differences were observed in the paired samples t-tests, suggesting an increase in mean eHR compared to mean rHR and an increase in peak eHR compared to peak rHR. Intra-class correlation coefficients revealed good reliability between the two mean resting HR measurements as the ICC = 0.87 with 95% confidence interval = 0.70-0.94. Complete esports statistics data can be found in Table 2. The match statistics showed that thirteen participants reported winning at least one round of Battle Royale solo mode during the 3-hour session. When participants were grouped into underweight/normal and overweight/obese BMI ranges, the independent samples t-test was not significantly different for hours of esports per week ($p = 0.1$; 17 ± 12 hours vs 10 ± 3.7 hours, respectively). The Pearson product-moment correlation coefficients are reported in Table 3. Additionally, the relationship among all HR variables showed statistically significant Pearson's r correlations.

Table 2. Participant Esport Match Statistics.

Variables	Mean ± Standard Deviation	Minimum	Maximum
Wins	1 ± 1.4	0	5
Kills	29 ± 18.9	3	65
AVG kills/match	1.9 ± 1.1	0	4
# Matches	16 ± 4	10	25

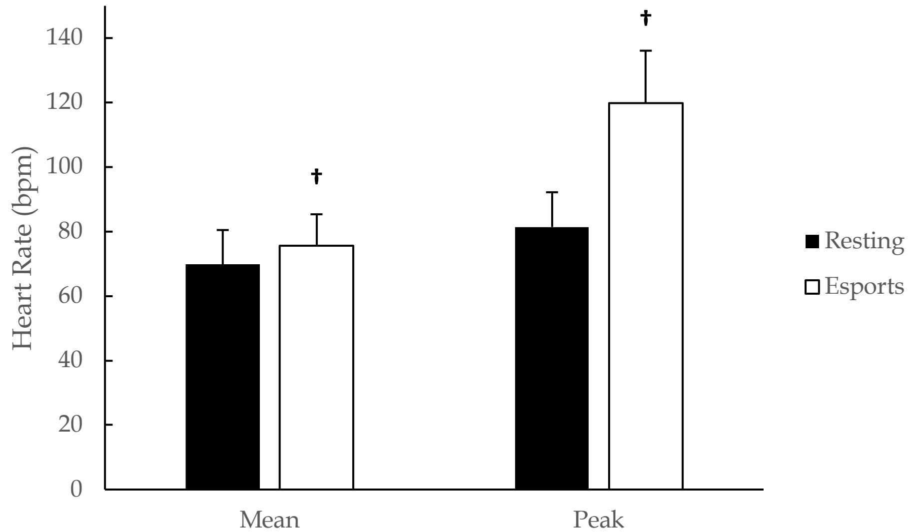

Figure 1. Mean and peak HR at rest and during esports session. † denotes $p < 0.01$ when compared to resting (n = 23).

Table 3. Correlation Matrix.

Variable	Mean rHR	Peak rHR	Mean eHR	Peak eHR	Wins	Kills	AVG kills	Esport hours	Exercise hours	BMI	Age	Matches
Mean rHR	-	-	-	-	-	-	-	-	-	-	-	-
Peak rHR	0.85†	-	-	-	-	-	-	-	-	-	-	-
Mean eHR	0.63†	0.65†	-	-	-	-	-	-	-	-	-	-
Peak eHR	0.44†	0.49†	0.77†	-	-	-	-	-	-	-	-	-
Wins	0.26	0.26	0.26	0.00	-	-	-	-	-	-	-	-
Kills	0.23	0.22	0.19	-0.06	0.69	-	-	-	-	-	-	-
AVG kills	0.14	0.09	0.23	-0.07	0.49*	0.93†	-	-	-	-	-	-
Esport hours	0.29	0.36	0.48†	0.43†	0.13	0.39*	0.39*	-	-	-	-	-
Exercise hours	-0.40*	-0.46†	-0.20	-0.50†	0.03	-0.02	0.06	-0.10	-	-	-	-
BMI	0.02	0.13	-0.20	-0.38*	0.24	-0.07	-0.14	-0.44†	0.12	-	-	-
Age	-0.12	0.02	-0.47†	-0.41†	-0.13	0.13	-0.01	-0.37	-0.20	0.37*	-	-
Matches	-0.06	-0.08	-0.43†	-0.38*	-0.34	-0.05	0.35*	-0.03	0.09	0.06	0.15	-

Note: Correlation coefficients between variables of interest. † denotes statistically significant correlation $p < 0.05$. * denotes a trend p = 0.06 - 0.09.

DISCUSSION

Within the last decade, the importance of esports to the sports community has increased exponentially along with the increased revenue generated. However, despite the growth, the physiological demands of esports have not been heavily researched. The main purpose of this investigation was to determine the HR response during a 3-hour seated session of the esport: Fortnite and to compare it to resting HR. Secondary aims of this study were to analyze possible relationships among demographics, gaming performance, and physiological data. We hypothesized that peak and mean HR would be elevated while playing Fortnite compared to resting HR.

Confirming our hypothesis, the increased HR (Figure 1) during the esports: Fortnite session suggests that esports' players experience a stressful physiological response to esports. The mean and peak HR values during the esports session showed an elevated response when compared to the mean and peak rHR. The elevated HR indicates a parasympathetic withdrawal and/or an upregulation of the sympathetic nervous system possibly through the release of catecholamines, although not measured during the current investigation. However, it is important to recognize that in average the mean eHR was lower than the peak rHR. This overlap between peak resting values and mean esports values can be attributed to a multitude of factors such as: the large periods during a Fortnite round that there is no combat, the different playing strategies –landing in an empty part of the map rather than landing on a crowded spot, the augmentation of peak rHR due to natural movement or change in breathing patterns.

The esports session in this examination was performed at home rather than in a tournament setting. Thus, one could expect the HR response to esports to be even higher when competing in live tournaments. The observed HR values reported are similar to HR responses observed in chess players during matches (28) and in college-aged adults when gambling (31). Further, it is comparable to the reported HR values of young adults while playing the Nintendo Wii Fit exergame, although esports does not include similar muscle-driven metabolic demands (10). Conversely, it was lower than the values observed on traditional sports participation (3, 4, 16, 21, 24, 29). However, future research should aim to assess esports HR response during competitive tournaments in live and online settings.

The mean BMI from the current investigation was (25.8 ± 3.8), ranging from 18.1 to 33.5. In accordance to previous research, the average BMI of young college-aged males does not correlate positively with electronic gaming time (30). In contrary, BMI was negatively associated with the amount of esports hours per week in a sample of recreational esport players who play more than 6-hours of esports per week. When comparing the hours of esports per week of underweight/normal to overweight/obese BMI range individuals, the groups showed to not be significantly different. However, the large variability of the reported esports hours per week may have played a role. The reported BMI is in the lower spectrum of the overweight range and goes against the general conception that esports participation leads to obesity. Further, the hours of physical exercise reported here showed to be over two times higher than what is recommended by ACSM guidelines as the minimum (150 min/wk) amount of exercise per week (20). However, ACSM guidelines state that the 150 minutes of exercise per week should be performed at a moderate intensity and in the current investigation the participants did not report the intensity of the exercise performed. Furthermore, the elevated volume of the reported esports participation per week of 6-40 hours could lead to an increase in all-cause mortality risk independently of leisure time physical activity due to the increased sitting time (14).

The Pearson product-moment correlations suggest with a moderate negative association that the individuals that play more hours of esports per week tend to have lower BMI. Hours of esports per week was also positively correlated to higher mean and peak eHR values. The latter is plausibly explained by the level of experience of the players. The participants that play more often are more likely to be more engaged and therefore reach the end of each match rather than losing in the beginning (i.e. before there is a build-up of arousal). Which is also suggested by the moderate negative association between the number of matches played and the mean eHR, given that the players with higher mean eHR played fewer matches during the 3-hour session (i.e. longer matches). The data also indicates that higher average kills per match showed a trend for a moderate positive relationship with winning more matches and could suggest that being offensive may be an appropriate strategy when participating in esport: Fortnite Battle Royale Solo mode. This is also supported by the 2019 Fortnite World Cup finals when the champion finished with the most kills (23 total kills in 6 rounds) during the event (8).

This study is not without limitations that should be addressed. Recruitment techniques were performed equally for both genders. Nonetheless, all twenty-four participants recruited were males. This uneven gender distribution may derive from a greater interest in esports by males compared to females. However, the reasons have yet to be examined. Similarly, the gender distribution at the 2019 Fortnite World Cup consisted of only males among the 100 finalists. It has been argued that the culture of the "hardcore" gaming community is dominated by young men and as a consequence it is unwelcoming to women (25). The self-reported height and weight could also have provided possible errors in the analysis as we could not confirm if the values reported were accurate and representative of their height and weight. Further, BMI was estimated using the self-reported height and weight. However, these variables are not the main variables of interest in this investigation.

Additionally, the broad range of esports expertise levels could have played a role in the variables of interest as the sample corresponds to a broader population. Future investigations could narrow down to regular, collegiate, or elite esports players, separately. Further, individuals were sent home to play with the HR monitors on and were asked to confirm they adhered to the protocol when they returned to the lab. Therefore, participants played at home and not in a controlled laboratory environment. However, this limitation increases the practical aspects of the study as young individuals usually engage in esports at home. During our HR measurements, we did not consider diurnal changes and nutritional status and how these variables could have influenced our HR data.

Given the amount of revenue generated by esports and the rising popularity, future research should aim to evaluate the elevated physiological stress during live competitive (collegiate and professional) esports tournaments. Those settings may elicit a greater response once there are external incentives and stimuli to fully engage the e-athletes (e.g. prize money, winning the tournament, representing your university, etc). Understanding the physiological response to esports is critical to better prepare e-athletes for competition, to provide the base for additional investigations, and especially for exercise prescription to potentially blunt the physiological stress during competition.

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