Journal of Rare Cardiovascular Diseases
ISSN: 2299-3711 (Print) | e-ISSN: 2300-5505 (Online)
www.jrcd.eu

RESEARCH ARTICLE

Heart Rate Variability: Physical Activity & Autonomic Stress Among Gamers

Mohammad Shoebuddin[1], Shahzeen Fatima Hussaini[2], Aliya Elamin Mohammed[3], Khan Shahina Mohamed[4], Nagat Basheer SiednaMohammeddeen[5]
[1,2,3,4,5] Department of Biomedical Sciences, College of Medicine, King Faisal University, Al-Ahsa 31982, Kingdom of Saudi Arabia.

*Corresponding Author
Mohammad Shoebuddin

Article History
Received: 08.09.2025
Revised: 24.09.2025
Accepted: 07.10.2025
Published: 23.10.2025

Abstract: ***Aims and Objectives:*** to study HRV in gaming teenagers with active and sedentary lifestyle. To measure HRV (RMSSD) parameter using wearable smart GABIT ring. ***Material and Methods:*** Study was done at local gaming stores in Aurangabad city. Teenage gamers in the age group of 15-19 years were enrolled for study. ***Sample size:*** n =80 subjects divided into two groups based on activity levels were chosen for study. A total sample size of 80 participants is justified by strong empirical evidence from Ti Wu et al. (2025). Results: Friedman test along with pairwise Wilcoxon Signed-Rank Tests within the group, and Mann-Whitney U test for inter group comparison shows statistically significant ***results.*** Conclusion: HRV is a noninvasive marker of how your heart responds to stress, specially autonomic stress. Our findings demonstrate that there is autonomic stress in teenagers who play video games. The effect being more pronounced in the group with teenagers having sedentary lifestyle as compared to the physically active group. To conclude, for better autonomic stability and cardiovascular health, there needs to be careful regulation of gaming habits and the encouragement of regular physical activity in teenagers.

Keywords: HRV (heart rate variability), HR, RMSSD (root mean square of successive difference), stress, IGD (internet gaming disorder).

INTRODUCTION

With increasing technical advancements, video games have seen upgrades that make them more realistic and addictive at the same time. The demand for video game consoles, online gaming, and mobile games has shown an uptrend in recent years. A study done in 2023 in Albaha, Saudi Arabia provides preliminary evidence on the prevalence of IGD among intermediate and high school students(1). A systematic review done in 2011 showed that youth were more inclined towards video games and TV rather than physical activity(2). It has been reported that the average playing time for esports players ranges from 20 to 25 hours per week. Prolonged gaming and training sessions often result in extended periods of sitting, which contributes to a sedentary lifestyle(3). PMG (problematic mobile gaming) as shown by previous studies is becoming very common nowadays in children and is associated with autonomic stress(4) Research has also shown that for autonomic disturbance to manifest in a videogame player, it is not necessary that the player be an addict to the video games(5).Heart rate variability (HRV) are the fluctuations in the time intervals between consecutive heart beats. HRV is regarded as an indicator of the functional state of the ANS and its adaptability to internal or external stimuli. Reduced HRV indicates relatively high sympathetic activation, disturbed regulation of the ANS, and inadequate adaptation of the cardiovascular system(6) Thus a good research option for us was to study HRV in gaming teenagers with active and sedentary lifestyle.

AIMS AND OBJECTIVES:

Our aim was to study the (RMSSD) in teenagers, which is a very important parameter of HRV and directly reflects the parasympathetic i.e. vagal modulation on heart rate. We wanted to achieve this by using a smart ring that was given to the study subjects to be worn on their index finger while playing videogames.

MATERIALS AND METHODS

The study was done in India in Aurangabad city of Maharashtra State. Local PlayStation stores and big malls were chosen for study that offered gameplay on hourly basis to our subjects. GABIT smart ring was given to subjects to be worn on right or left index finger whichever was more suitable to the subjects. The place of gaming had climate control by air conditioners set to 25 degrees Celsius. There was provision for drinking water at the gaming sites. Morning hours between 10 am to 12 pm were chosen for active video gaming by subjects of the two study groups.

Sample size:

Healthy 80 teenage gamers in total, categorized into two groups as n1= 40 who were physically active and n2= 40 who had sedentary lifestyle were enrolled for study. Physically active subjects were defined as those playing any aerobic outdoor games like football, tennis, badminton etc. 60 minutes per day of outdoor gameplay daily for the whole week was considered adequate and sufficient. A total sample size of 80 participants is justified by strong empirical evidence from Ti Wu et al. (2025)(7). Their highly similar study, which also investigated heart rate and HRV changes (including

RMSSD) during esports activities using a pre-during-post design and non-parametric analyses, successfully detected significant effects with 80 participants with an overall Friedman test p-value < 0.001). This provides a solid basis for ensuring adequate statistical power to detect similar meaningful physiological changes in the present study.

Inclusion Criteria:
Forty-teenage gamers were enrolled in our study and categorized as either sedentary or physically active. Physical activity was defined for n1 teenagers as regularly engagement for at least 60 minutes of daily aerobic outdoor gameplay. For n2, a complete sedentary lifestyle with no outdoor games or any physical activity of any kind was kept as inclusion criteria.

Teenage male subjects in the age group of 15 to 19 yrs were enrolled for study. Active and regular gamers with a history of at least 2 to 3 hours of daily gaming for at least 2 days a week were enrolled.

Exclusion Criteria:
Children with diagnosed chronic illnesses (e.g., asthma, diabetes, ADHD), taking medications that influence heart rate, or autonomic functions were excluded from the study. Non active video gamers. Gamers with h/o cardiovascular, respiratory illness or any physical or mental disability were excluded from our study.

PROCEDURE:
The study was done at a local PlayStation gaming zone in Aurangabad city of Maharashtra state in India. Ethical clearance was taken prior to starting the study. A total of n=80 subjects were recruited for the study. The subjects were categorized into 2 groups n1=40 and n2=40 depending upon activity and lifestyle. This was done by giving them a questionnaire that reflected their level of daily physical activity and the kind of outdoor gameplay. Simple random sampling was done to finally get 40 subjects in each group. After taking consent and explaining the nature of study, the subjects were given GABIT smart ring to be worn on their index finger. RMSSD values were noted 30 mins at rest i.e. before starting the game, 30 mins during active videogaming and 30 mins after video gameplay was over. RMSSD values were obtained from android smartphone applications that was synchronized with the smart ring. The android smartphone was connected via Bluetooth with the GABIT smart ring. RMSSD values of the two groups were then compared for any statistical significance.

Figure 1: Esports[12]

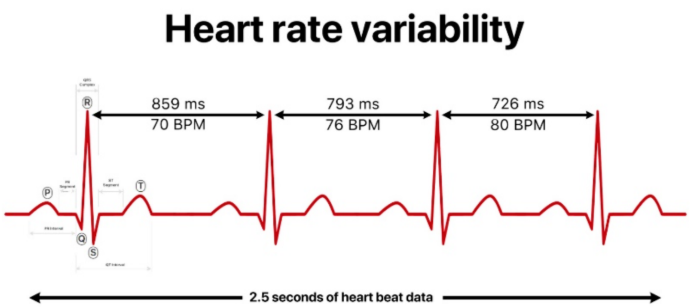

Figure 2: HRV[13]

Statistical analysis:
MedCalc statistical analysis software v23.2.6 was used to analyze the results. We performed the Friedman Test on the three HRV measures (HRV_Before, HRV_During, HRV_After) gaming for the 40 subjects in each of the study groups.
The Friedman test is significant if ($p < 0.05$), it indicates a significant change in HRV over time within the group that is tested.
As the Friedman test was significant, pairwise Wilcoxon Signed-Rank Tests (non-parametric paired t-test) was applied to compare:
HRV_Before vs. HRV_During gaming.
HRV_Before vs. HRV_After gaming.
HRV_During vs. HRV_After gaming

Only after applying for the Bonferroni correction of 0.017 was the level of significance established(8).

To compare HRV between the Active and Sedentary groups, we performed a Mann-Whitney U test.
HRV_Before vs. HRV_During gaming.
HRV_Before vs. HRV_After gaming.
HRV_During vs. HRV_After gaming

U-statistics, Z-statistics, and p-value were recorded.

RESULTS AND OBSERVATIONS:

Findings of the study are described in tables below.

Table 1: baseline characteristics of the study subjects in the study.

Group	Age yrs	Height cms	Weight kg	BMI kg/m2
n1 Active Gamers	17.2 ± 1.4536	150.35 ± 7.0018	51.20 ± 5.5062	22.72 ± 2.5799
n2 Sedentary Gamers	16.75 ± 1.4632	153.17 ± 6.1971	52.50 ± 5.5747	22.40 ± 2.3079

Table 2: descriptive statistics

Group	HRV_BEFORE	HRV_DURING	HRV_AFTER
n1 Active Gamers	40.15± 4.7889	32.8750 ± 3.8841	38.4000 ± 5.5276
n2 Sedentary Gamers	39.17 ± 4.9349	25.8000 ± 4.8527	32.3750 ± 5.1674

Table 3: comparison within the group

Group	Friedman Test		Wilcoxon Signed-Rank Tests			Bonferroni correction
n1 Active Gamers	X^2_F	68.199	HRV Before VS During.	Z= -5.518852	P < 0.0001	0.017
	df	2	HRV Before VS After	Z= -3.813796	P < 0.0001	
	p	< .001	HRV During VS After	Z= -5.264465	P < 0.0001	
n2 Sedentary Gamers	X^2_F	60.608	HRV Before VS During.	Z= -6.324555	P < 0.0001	0.017
	df	2	HRV Before VS After	Z= -6.324555	P < 0.0001	
	p	< .001	HRV During VS After	Z= -6.324555	P < 0.0001	

Table 4: comparison between the groups

	Mann-Whitney U Test		
	U-statistic	Z-statistic	p-value
HRV Before (Active vs. Sedentary)	716.50	-0.806	0.4203
HRV During (Active vs. Sedentary)	222.50	-5.570	< 0.0001
HRV After (Active vs. Sedentary)	326.50	-4.579	< 0.0001

DISCUSSION

Active group:
Within the active group, there was a significant change in HRV over the three time points, $X^2F=68.199$ & $p<0.001$).

Post-hoc analyses revealed that HRV significantly decreased from Before to During gameplay ($Z=-5.518852$, $p<0.001$), and then significantly increased from During to After gameplay (Z $Z=-5.264465$, $p<0.001$).

Sedentary group:
Within the active group, there was a significant change in HRV over the three time points, $X^2F=60.608$ & $p<0.001$).

Post-hoc analyses revealed that HRV significantly decreased from Before to During gameplay ($Z=-6.324555$, $p<0.001$), and then significantly increased from During to After gameplay ($Z=-6.324555$, $p<0.001$).

Inter group comparison:
HRV Before: There is no significant difference in HRV between Active and Sedentary groups before the activity ($p = 1.0000$).

HRV During: There is a significant difference in HRV between the groups during the activity ($p < 0.0001$).
HRV After: There is also a significant difference in HRV between the groups after the activity ($p < 0.0001$). After applying the Bonferroni correction (adjusted alpha = 0.0167), the differences during and after remain statistically significant.

Thus, both the groups show fall and recovery in HRV while playing the game and after the gaming was over respectively. However, statistics prove that the fall is more in sedentary groups as compared to active groups, and the post gaming recovery is faster in active groups as compared to the sedentary groups.

The cognitive challenges and emotional stress inherent in competitive and advanced videogames put the gamer at mental and physical stress. In fact, top athletes in esports can make up to 10 actions per second or 500–600 actions per minute(9). It is a well-established fact that acute mental stress induces significant alterations in HRV parameters among healthy adults, characterized by reduced vagal tone and elevated sympathetic modulation. HRV may serve as a useful biomarker for early stress detection and autonomic function monitoring in clinical and occupational settings(10). A review demonstrated the positive effectiveness of different physical training modalities on autonomic function in young and early middle-aged healthy adults, as indicated by an increase of different HRV parameters at rest.(11)

CONCLUSION

HRV is a noninvasive marker of how your heart responds to stress specially autonomic stress. Our findings demonstrate that there is autonomic stress in teenagers who play video games. While both groups showed a significant decrease in HRV during gameplay (as evidenced by the Friedman tests), the magnitude of this decrease and the subsequent recovery differed significantly between the two groups. Active individuals demonstrated a smaller drop in HRV during gaming and a more complete recovery post-gameplay compared to their sedentary counterparts. This indicates that regular physical activity may confer greater physiological resilience to handle acute autonomic stress. To conclude, for better autonomic stability and cardiovascular health, there needs to be careful regulation of gaming habits and the encouragement of regular physical activity in teenagers

REFERENCES

1. Alghamdi MH, Alghamdi MM. Prevalence of Internet Gaming Disorder Among Intermediate and High School Students in Albaha, Saudi Arabia: A Cross-Sectional Study. Cureus. 2023 Apr 4;
2. Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. Vol. 8, International Journal of Behavioral Nutrition and Physical Activity. 2011.
3. Almuhtadi Y, Alageel S. Online Gaming and Healthy Lifestyles: A Qualitative Study of Gamers in Saudi Arabia. Societies. 2025 Apr 1;15(4).
4. Chin SC, Chang YH, Huang CC, Chou TH, Huang CL, Lin HM, et al. Altered Heart Rate Variability During Mobile Game Playing and Watching Self-Mobile Gaming in Individuals with Problematic Mobile Game Use: Implications for Cardiac Health. Psychol Res Behav Manag. 2024;17:2545–55.
5. Kim JY, Kim HS, Kim DJ, Im SK, Kim MS. Identification of video game addiction using heart-rate variability parameters. Sensors. 2021 Jul 2;21(14).
6. McCraty R, Shaffer F. Heart rate variability: New perspectives on physiological mechanisms, assessment of self-regulatory capacity, and health risk. Vol. 4, Global Advances In Health and Medicine. GAHM LLC; 2015. p. 46–61.
7. Wu T, Lee PY, Tu JA, Wang HH, Chao HC, Chen CH, et al. Changes in heart rate variability induced by E-sports activities. Front Physiol. 2025;16.
8. Jean Dunn O. MULTIPLE COMPARISONS AMONG MEANS.
9. Ketelhut S, Nigg CR. Heartbeats and high scores: esports triggers cardiovascular and autonomic stress response. Front Sports Act Living. 2024;6.
10. Govindbhai Ajudiya N, Anupbhai Machhar P, Shaileshbhai Patel M, Dineshsinh Rathod M.

Evaluation of Heart Rate Variability in Response to Acute Mental Stress in Healthy Adults. International Journal of Life Sciences. 2025;14(6).

11. Grässler B, Thielmann B, Böckelmann I, Hökelmann A. Effects of Different Training Interventions on Heart Rate Variability and Cardiovascular Health and Risk Factors in Young and Middle-Aged Adults: A Systematic Review. Vol. 12, Frontiers in Physiology. Frontiers Media S.A.; 2021.
12. Top 10 Best Online Games to Play With Friends [Internet]. [cited 2025 Sep 3]. Available from: https://www.medsnews.com/psychology-sociology/top-10-best-online-games-to-play-with-friends/
13. Fall Prevention Missouri | Pain Prevent [Internet]. [cited 2025 Sep 3]. Available from: https://painprevent.com/heart-rate-variability/