ELMER PRESS

Short Communication

J Endocrinol Metab. 2024;14(1):59-62

Video Gaming Reduces Circulating Creatine Levels in Young Male E-Gamers

Bogdan Andjelic[a, b], Nikola Todorovic[a], Jovana Panic[c], Milan Vranes[a, c], Sergej M. Ostojic[a, d, e, f]

Abstract

Background: No studies so far assessed whether acute video gaming affects creatine metabolism, a metabolic pathway critical in replenishing immediate energy for cells and tissues with high and intermittent energy fluctuations. In this study, we explored whether a single session of prolonged video gaming alters circulating biomarkers of creatine metabolism in young male e-gamers.

Methods: A total of 12 young men (age 25.6 ± 3.8 years) signed an informed consent to volunteer in this quasi-experimental before-after pilot trial. Each participant took part in a single 6-h session of competitive online ranked matches in a popular tactical first-person shooting game.

Results: A 6-h video gaming session resulted in a statistically significant drop in serum creatine levels (from 27.6 ± 7.5 µmol/L at baseline to 22.9 ± 8.3 µmol/L at follow-up; P = 0.029). The mean reduction in serum creatine was 4.70 µmol/L (95% confidence interval (CI): - 2.3 to 11.7), with a moderate-to-large effect size (d = 0.59). Serum creatinine concentrations tended to drop after the gaming session from 88.1 ± 15.5 to 78.2 ± 19.8 µmol/L (P = 0.077).

Conclusion: Our findings indicate that creatine homeostasis is sensitive to video gaming perhaps owing to more creatine from the circulation utilized as an energy source for active tissues, including the brain.

Keywords: Creatine; Creatinine; E-gaming; Energy metabolism

Manuscript submitted November 16, 2023, accepted December 15, 2023
Published online January 10, 2024

[a]Applied Bioenergetics Lab, Faculty of Sport and Physical Education, University of Novi Sad, Novi Sad, Serbia
[b]Sport and Exercise Sciences Research Unit, University of Palermo, Palermo, Italy
[c]Department of Chemistry, Biochemistry and Environmental Protection, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia
[d]Department of Nutrition and Public Health, University of Agder, Kristiansand, Norway
[e]Faculty of Health Sciences, University of Pecs, Pecs, Hungary
[f]Corresponding Author: Sergej M. Ostojic, Applied Bioenergetics Lab, Faculty of Sport and Physical Education, University of Novi Sad, 21000 Novi Sad, Serbia. Email: sergej.ostojic@chess.edu.rs

doi: https://doi.org/10.14740/jem923

Introduction

Video gaming has grown rapidly across the globe during the past few years. According to the latest data, there are approximately 3.09 billion active video gamers worldwide in 2023 [1], and the global average for a single gaming session duration was up to 5.1 h [2]. The health consequences of excessive video gaming drive much attention [3, 4], with the World Health Organization adding gaming disorder to the 11th Revision of the International Classification of Diseases based on reviews of available evidence on repetitive patterns of gaming behavior [5]. However, the impact of a single session of video gaming attracted much less research interest, giving grounds for quantifying a possible acute metabolic burden of this ever-popular form of leisure activity. Recent studies demonstrated a number of biochemical correlates of single-session video gaming [6], including an increase in glucose metabolism and energy expenditure [7], cortisol/catecholamines alterations [8], and oxidant-antioxidant perturbations [9]. Interestingly, no studies so far assessed whether acute video gaming affects creatine metabolism, a metabolic pathway critical in replenishing immediate energy for cells and tissues with high and intermittent energy fluctuations [10]. The aim of this study was to explore whether a single session of prolonged video gaming alters circulating biomarkers of creatine metabolism in young male e-gamers. We hypothesized that an extended video gaming session would reduce blood biomarkers related to creatine metabolism.

Materials and Methods

A total of 12 young men (age 25.6 ± 3.8 years, body mass index 25.9 ± 2.5 kg/m^2) signed an informed consent to volunteer in this quasi-experimental before-after pilot trial. All participants had six or more years of experience in video gaming, spending3 - 9 h a day playing games from first-person shooting (FPS) and multiplayer online battle-arena (MOBA) genres. The participants were apparently healthy non-vegetarians, free from using any creatine-containing supplements in the past 3 months. Additionally, all participants were asked to refrain from extensive physical activity and video gaming at least 24 h prior to the study kick-off. The gaming session was performed in a private professional e-sports club (Matrix Gaming, Novi Sad, Serbia) between 08:00 and 15:00. Each par-

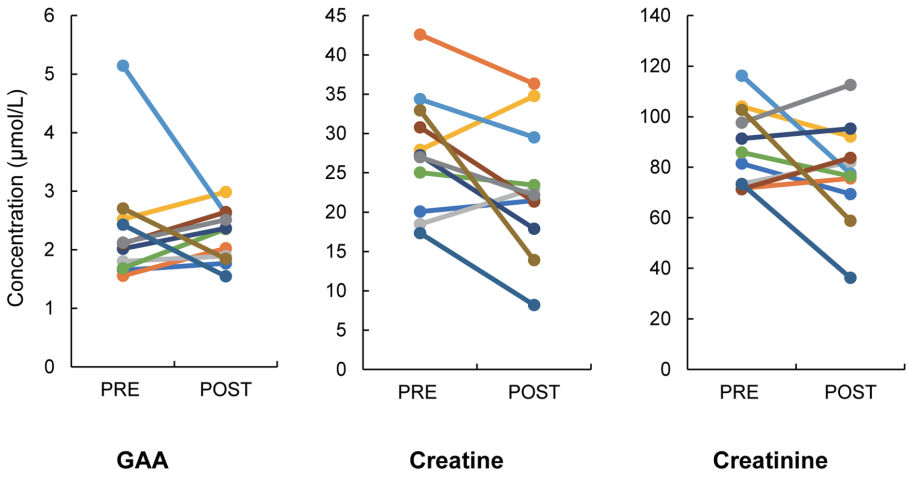

Figure 1. Individual changes in serum guanidinoacetic acid (GAA), creatine and creatinine after a single session of e-gaming in young men (n = 11).

ticipant took part in a single 6-h session of competitive online ranked matches in CounterStrike: Global Offensive™ (Valve, Bellevue, WA, USA), a popular tactical FPS. Throughout the 6-h gaming period, each participant was provided with 2 L of water to prevent dehydration, and a vegetarian sandwich (250 kcal) to break fasting but minimize interference on creatine turnover via food sources. Blood samples were collected after an overnight fast immediately upon arrival at the club (baseline) and after the end of gaming session (follow-up). All samples were immediately taken to the lab, centrifuged within 15 min at 3,000 × g, with serum stored at - 80 °C for further analyses. The serum was analyzed for creatine, guanidinoacetic acid (GAA, a direct precursor of creatine), and creatinine (an end-product of non-enzymatic conversion of creatine) using modified liquid chromatography-tandem mass spectrometry (1200 Series LC System, Agilent Technologies Inc., Santa Clara, CA, USA), as described previously [11].

The ethical approval to conduct the study was granted by the local IRB at the University of Novi Sad (# 23-1462). The study was conducted according to the guidelines of the Declaration of Helsinki.

Results

Eleven participants (n = 11) completed the trial, with one participant (age 23) deciding to discontinue participation and thus being removed from the further analyses. All participants had baseline serum creatine, GAA, and creatinine levels within the reference ranges, except for one participant (age 23, weight 81.6 kg) who had mildly elevated serum GAA (5.1 µmol/L) and creatinine levels (116.2 µmol/L). A 6-h video gaming session resulted in a statistically significant drop in serum creatine levels (from 27.6 ± 7.5 µmol/L at baseline to 22.9 ± 8.3 µmol/L at follow-up; P = 0.029). The mean reduction in serum creatine was 4.70 µmol/L (95% confidence interval (CI): - 2.3 to 11.7), with a moderate-to-large effect size (d = 0.59). The highest reduction in serum creatine (57.8%) was found in a 29-year-old participant. Serum creatinine concentrations tended to drop after the gaming session (from 88.1 ± 15.5 to 78.2 ± 19.8 µmol/L; P = 0.077), and the effect size was moderate-to-large (d = 0.56). Circulating GAA non-significantly diminished after the session (2.3 ± 1.0 µmol/L at baseline vs. 2.2 ± 0.4 µmol/L at follow-up; P = 0.359). In the follow-up, most participants had creatinine levels within the reference values (61.9 to 114.9 µmol/L), except for two men, aged 29 and 22, who had creatinine concentrations below a lower cut-off value (58.8 and 36.2 µmol/L, respectively). Individual changes for creatine biomarkers after a single session of e-gaming are depicted in Figure 1.

Discussion

Our preliminary trial demonstrated a significant effect of single-session video gaming on circulating creatine levels in male e-gamers. Six hours of competitive online game reduced circulating creatine for up to 19.1 µmol/L, with other biomarkers of creatine turnover (GAA and creatinine) tending to drop after the gaming session. This indicates that creatine homeostasis is sensitive to video gaming perhaps owing to more creatine from the circulation utilized as an energy source for active tissues, including the brain. Previous studies showed that creatine levels can decrease acutely upon brain activation [12]. Since video gaming increases neural activity across several brain regions [13], a 6-h session of FPS game might deplete brain creatine reservoir, leading to cerebral uptake of creatine from the circulation as an alternative source of rapidly mobilizable energy. Creatine fall-off might also be due to enhanced utilization via other energy-demanding tissues active during video gaming [14], and/or impaired production due to a video gaming-induced circulation restriction in organs involved in creatine biosynthesis [15]. It remains currently unknown whether creatine deficit is associated with compromised game performance or any health consequences in e-gamers.

Our study is not without limitations. These involve the absence of a control group showing typical daily variations in creatine levels, which would enable a comparison with the experimental group. In this study, our focus was on a relatively small sample of young male e-gamers. Whether single (or repeated) gaming sessions produce comparable effects in other gaming demographics, such as women, children, or middle-aged adults, is currently unknown and necessitates further investigation. In addition, we have not evaluated video game performance during the study, and a possible correlation between game performance (also subjective feeling of fatigue and concentration difficulties) with respect to the highest and lowest creatine values. Further studies are warranted to expand our findings by recruiting more diverse and larger samples, and accounting for different games and play time spans, encompassing shorter gaming intervals along with morning versus evening plays. In addition, addressing creatine biodynamics during video gaming across the human body via isotopic tracer studies and magnetic resonance spectroscopic imaging would help to understand organ-specific creatine turnover. A separate interventional trial should also evaluate a possibility to acutely correct creatine shortage driven by video gaming via dietary supplementation or providing foods rich in creatine in this population.

Acknowledgments

None to declare.

Financial Disclosure

This research received no external funding.

Conflict of Interest

Each author declares that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangement, etc.) that might pose a conflict of interest in connection with the submitted article.

Informed Consent

Written informed consent was obtained from participants involved in the study.

Author Contributions

BA: conceptualization; investigation; methodology; validation; visualization; writing - review and editing. NT: investigation; methodology; validation; visualization; writing - review and editing. JP: investigation; methodology; validation; visualization; writing - review and editing. MV: data curation; formal analysis; investigation; methodology; software; writing - review and editing. SMO: conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; software; supervision; visualization; writing - original draft; writing - review and editing.

Data Availability

The authors declare that data supporting the findings of this study are available within the article. Any inquiries regarding supporting data availability of this study should be directed to the corresponding author.

References

1. Exploding Topics. How many gamers are there? (New 2023 Statistics). Available at: https://explodingtopics.com/blog/number-of-gamers (Assessed on July 7, 2023).
2. Statista. Time spent playing binge gaming in selected countries worldwide. 2021. Available at: https://www.statista.com/statistics/936732/consecutive-time-spent-playing-video-games-worldwide/ (Assessed on July 7, 2023).
3. Griffiths M. Video games and health. BMJ. 2005;331(7509):122-123. doi pubmed pmc
4. Prot S, McDonald KA, Anderson CA, Gentile DA. Video games: good, bad, or other? Pediatr Clin North Am. 2012;59(3):647-658. doi pubmed
5. World Health Organization. International Statistical Classification of Diseases and Related Health Problems (ICD). 2022. Available at: https://icd.who.int/en.
6. Carpita B, Muti D, Nardi B, Benedetti F, Cappelli A, Cremone IM, Carmassi C, et al. Biochemical correlates of video game use: from physiology to pathology. A Narrative Review. Life (Basel). 2021;11(8):775. doi pubmed pmc
7. Chaput JP, Visby T, Nyby S, Klingenberg L, Gregersen NT, Tremblay A, Astrup A, et al. Video game playing increases food intake in adolescents: a randomized crossover study. Am J Clin Nutr. 2011;93(6):1196-1203. doi pubmed
8. Phan-Hug F, Thurneysen E, Theintz G, Ruffieux C, Grouzmann E. Impact of videogame playing on glucose metabolism in children with type 1 diabetes. Pediatr Diabetes. 2011;12(8):713-717. doi pubmed
9. Podrigalo LV, Iermakov SS, Jagiello W. Metabolic and endocrine changes determined in saliva of adolescents engaged in computer gaming. Biomed Res Int. 2020;2020:1649759. doi pubmed pmc
10. Wallimann T, Tokarska-Schlattner M, Schlattner U. The creatine kinase system and pleiotropic effects of creatine. Amino Acids. 2011;40(5):1271-1296. doi pubmed pmc
11. Jovanov P, Vranes M, Sakac M, Gadzuric S, Panic J, Maric A, Ostojic S. Hydrophilic interaction chromatography coupled to tandem mass spectrometry as a method for simultaneous determination of guanidinoacetate and creatine. Anal Chim Acta. 2018;1028:96-103. doi pubmed
12. Rango M, Castelli A, Scarlato G. Energetics of 3.5 s neu-

ral activation in humans: a 31P MR spectroscopy study. Magn Reson Med. 1997;38(6):878-883. doi pubmed
13. Brilliant TD, Nouchi R, Kawashima R. Does Video Gaming Have Impacts on the Brain: Evidence from a Systematic Review. Brain Sci. 2019;9(10):251. doi pubmed pmc
14. Park JHM, Kang SYP, Lee SGP, Jeon HSP. The effects of smart phone gaming duration on muscle activation and spinal posture: Pilot study. Physiother Theory Pract. 2017;33(8):661-669. doi pubmed
15. Gwinup G, Haw T, Elias A. Cardiovascular changes in video-game players. Cause for concern? Postgrad Med. 1983;74(6):245-248. doi pubmed