International Journal of Endorsing
HEALTH SCIENCE RESEARCH

IJEHSR

Original Article

Effect of high-intensity exercise on Gamma-Glutamyl Transferase levels in novice athletes.

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Doi: 10.29052/IJEHSR.v13.i1.2025.22-27
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Received 29/12/2024
Accepted 04/01/2025
First Published 01/03/2025

OPEN ACCESS

Abstract

Background: The liver plays a critical role in various physiological functions, including metabolism, detoxification, and immune response. Gamma-glutamyl transferase (GGT) is an essential enzyme involved in glutathione metabolism and serves as a biomarker of oxidative stress and liver function. This study aimed to examine the effect of high-intensity exercise on GGT levels among novice athletes.

Methodology: An experimental research study was conducted among male athletes registered at the Gymnasium of the University of the Punjab, Lahore, Pakistan. Twenty (20) participants were voluntarily selected and randomly assigned to two groups: the Control Group (CG) and the Experimental Group (EG), with ten (10) subjects in each. The EG followed an eight-week high-intensity exercise protocol, while the CG maintained their usual physical activity routine. Blood samples (5 ml) were collected from all participants and labeled with unique identification codes. GGT tests were performed to assess potential risks and benefits associated with high-intensity exercise.

Results: The study findings revealed a significant impact of high-intensity exercise on GGT levels. In the EG, the pre-test mean GGT levels were 16.65±0.88, which increased to 24.15±1.39 post-intervention. Similarly, in the CG, the pre-test levels were 15.61±0.84, rising to 23.20±1.32. The observed differences were statistically significant ($p < 0.05$), indicating that high-intensity exercise influences GGT concentrations in novice athletes.

Conclusion: It is concluded that the high-intensity exercise significantly impacts GGT levels, potentially due to increased metabolic activity and oxidative stress adaptation.

Keywords

High-Intensity Exercise, Gamma-Glutamyl Transferase, Oxidative Stress, Liver Function, Novice Athletes, Metabolism, Exercise Physiology.

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Introduction

The liver is one of the most vital organs of the human body, playing a central role in metabolism, digestion, detoxification, immunity, and the storage of essential vitamins. Gamma-glutamyl transferase (GGT) is a key enzyme involved in glutathione metabolism, which serves as a crucial antioxidant protecting cells from oxidative damage[1]. Elevated serum GGT levels are often considered a biomarker of oxidative stress, liver dysfunction, and cardiovascular health complications. Oxidative stress results from an imbalance between reactive oxygen species (ROS) and the body's antioxidant defense system, leading to cellular damage and increased risk of metabolic disorders[2,3]. Given its role in maintaining cellular redox balance, monitoring GGT levels provides valuable insight into liver function and overall metabolic health.

Physical activity has been widely recognized for its positive impact on oxidative stress regulation and liver enzyme activity. Regular exercise has been associated with improved metabolic profiles, particularly in individuals who are physically inactive or suffering from obesity and hypertension[3]. The ability of exercise to enhance antioxidant defenses and reduce oxidative stress underscores the broader significance of GGT as a biomarker of liver health. Notably, research suggests that dietary factors, such as isoflavones, do not significantly influence hepatic enzyme synthesis when combined with exercise, further emphasizing the independent role of physical activity in maintaining optimal GGT levels[4]. The relationship between exercise and metabolic health suggests that structured physical activity may serve as a preventative measure against liver dysfunction and related diseases.

Elevated GGT levels have been linked to various metabolic conditions, including oxidative stress, liver disease, and cardiovascular disorders. Studies indicate that regular exercise may exert a protective effect by regulating GGT levels and enhancing liver function. For instance, high-level kickboxing athletes have demonstrated significant biochemical changes in response to their training routines, including fluctuations in liver enzyme activity such as GGT[5]. However, different exercise modalities may yield varying effects on liver enzymes. While some studies report significant alterations in GGT levels following intense training regimens, others indicate minimal changes in response to moderate exercise, such as a six-week program of physical and flexibility exercises[6,7]. Given these mixed findings, further research is needed to understand the specific impact of high-intensity exercise on GGT levels and its potential implications for metabolic and liver health.

Methodology

Trial Design

This study was designed as a randomized controlled trial (RCT) to evaluate the effects of an eight-week self-exercise protocol on plasma gamma-glutamyl transferase (GGT) levels in male athletes. Participants were randomly assigned to either the Control Group (CG) or the Experimental Group (EG). The study followed CONSORT guidelines to ensure methodological rigor.

Participants

The study recruited male athletes aged 20–30 years registered at the Gymnasium of the University of the Punjab, Lahore, Pakistan. A total of 20 participants voluntarily consented to participate and were assessed for eligibility based on the following inclusion criteria:

- Male students between 20-30 years of age.
- No known chronic health conditions.
- No ongoing medications that could affect the study outcomes.
- Willingness to participate voluntarily.

Exclusion criteria included individuals with chronic diseases (e.g., cardiovascular disorders, metabolic syndromes) or those on medications influencing GGT levels. Informed written consent was obtained from all participants before enrollment.

Interventions

Participants in the Experimental Group (EG) underwent a structured eight-week exercise intervention, designed to progressively increase in

intensity. The exercise volume and intensity were determined using the maximum heart rate recovery formula, incorporating:

- 60%–85% of peak heart rate.
- 50%–80% of heart rate reserve.
- 50%–80% of peak VO_2.

The control group (CG) did not receive any structured intervention and maintained their usual physical activity routines. Adherence to the intervention was monitored weekly to ensure compliance.

Outcomes

The primary outcome measure was the change in plasma GGT levels pre- and post-intervention. Secondary outcomes included anthropometric measurements (weight, height), blood oxygen levels (measured via pulse oximetry), and various skill-related fitness assessments.

Sample Size

The required sample size was determined using G*Power statistical software, ensuring adequate power (80%) to detect significant differences between groups. A sample of 20 participants (10 per group) was deemed sufficient to achieve statistical significance at an alpha level of 0.05.

Randomization

Participants were randomly assigned to either the CG or EG using a computer-generated random sequence. Randomization ensured an equal allocation (1:1 ratio), minimizing selection bias. A research assistant not involved in data collection conducted the allocation to maintain objectivity.

Blinding

Due to the nature of the intervention, participants were not blinded to their assigned group. However, outcome assessors and laboratory personnel analyzing plasma GGT levels were blinded to group allocation to minimize measurement bias.

Ethical Considerations

Ethical approval was obtained from the Ethical and Research Review Committee of the Department of Sports Sciences and Physical Education, University of the Punjab, Lahore, Pakistan. Written informed consent was obtained from all participants before study initiation. Participants were informed about the study's objectives, potential risks, and benefits. Confidentiality and anonymity were maintained throughout the study.

Statistical Methods

Data were analyzed using SPSS (Version 26), with descriptive statistics used to summarize demographic and baseline characteristics. To assess the impact of high-intensity exercise on GGT levels, inferential statistical analyses were conducted. A Paired Samples t-test was performed to compare pre- and post-intervention GGT levels within each group, while an Independent Samples t-test was used to evaluate between-group differences at baseline and post-intervention. Statistical significance was set at $p < 0.05$, and all analyses were conducted following the intention-to-treat principle.

Results

Recruitment

Participants were recruited from the Gymnasium of the University of the Punjab, Lahore, Pakistan. A total of 20 eligible male athletes aged 20–30 years voluntarily consented to participate in the study. Random allocation resulted in two equal groups: Control Group (CG, n=10) and Experimental Group (EG, n=10). No participants withdrew from the study, ensuring complete data collection for analysis.

Baseline Data

Baseline characteristics, including age, weight, height, and initial GGT levels, were similar across both groups, confirming that randomization effectively minimized selection bias. The mean and standard deviation of GGT levels at pretest for CG was 15.50±0.843, while for EG, it was 16.65±0.875, indicating no significant baseline differences.

Numbers Analyzed

All 20 participants completed both pre- and post-intervention assessments. Data from all participants were included in the final analysis, adhering to the intention-to-treat principle.

Outcomes and Estimation

Table 1 presents the pre- and post-test GGT levels for CG and EG. The mean GGT level in CG increased from 15.50±0.843 to 23.20±1.31 post-intervention, showing a significant change (p=0.000). Similarly, EG demonstrated an increase from 16.65±0.875 to 24.15±1.52, with statistical significance (p=0.000).

These findings suggest that both groups experienced significant changes in GGT levels post-intervention, with EG showing slightly greater improvement.

Between-group analysis revealed no statistically significant difference in GGT levels between CG and EG at both pre-test (p = 0.806) and post-test (p = 0.877), indicating that while both groups exhibited significant intragroup changes, the magnitude of change did not significantly differ between the groups.

Table 1: Pre- and post-test GGT results of CG and EG

Groups	Pre-Test	Post-Test	p-value
CG	15.50±0.84	23.20±1.31	<0.01*
EG	16.65±0.87	24.15±1.52	<0.01*

Control Group-CG; Experimental Group-EG

*p<0.05 is considered statistically significant

Table 2: Between-group comparisons of Pre- and Post-Test GGT results.

Variables	Groups	Mean±SD	Df	T	p-value
Pre-test	CG	16.60±0.84	18	-0.249	0.806
	EG	16.70±0.94			
Post-test	CG	24.24±1.31	18	0.157	0.877
	EG	24.10±1.52			

Ancillary Analyses

Additional analyses were conducted to assess the correlation between demographic factors (age, weight, height) and GGT levels. No significant associations were found, suggesting that the observed changes in GGT levels were primarily attributable to the intervention.

Harms

No adverse events or harm-related issues were reported during the study. Participants tolerated the intervention well, with no reported cases of injury, excessive fatigue, or withdrawal due to discomfort.

Discussion

The findings of this study demonstrate that high-intensity exercise significantly influences GGT levels in male athletes. The results indicate a marked increase in GGT levels post-intervention in both the experimental and control groups, with the EG showing a higher mean increase (24.15±1.39) compared to the CG (23.20±1.32). These findings align with previous research[8], which highlights the association between physical exercise and fluctuations in GGT levels, emphasizing its impact on oxidative stress, liver function, and overall metabolic health. Elevated GGT levels have been linked to increased oxidative stress, a condition associated with metabolic disorders and cardiovascular diseases. Therefore, this study supports the hypothesis that physical activity plays a crucial role in modulating oxidative stress markers, potentially mitigating health risks associated with high GGT levels. Furthermore, the study reinforces the findings of Karabük, who suggested that regular exercise contributes to disease prevention, particularly in conditions such as atherosclerosis and non-alcoholic fatty liver disease[9]. Exercise is known to improve liver

function and metabolic regulation, leading to better cardiovascular outcomes. The observed rise in GGT levels in this study could be a physiological response to increased metabolic demands during high-intensity workouts. The study by Golomb further substantiates these findings, indicating that moderate-to-vigorous physical activity correlates negatively with GGT levels in individuals with high alcohol consumption[10]. This suggests that while exercise-induced GGT elevations might be transient, long-term engagement in structured physical activity could help regulate oxidative stress and improve liver enzyme profiles. These findings emphasize the potential role of exercise as an intervention strategy for maintaining liver health and reducing disease risks.

Additionally, oxidative stress has been extensively studied in relation to metabolic diseases, highlighting GGT as a non-specific biomarker of oxidative stress[11-19]. Factors such as elevated plasma glucose and triglyceride levels contribute to oxidative stress, placing individuals with impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) at a heightened risk. The association between exercise and GGT levels in pre-diabetic individuals suggests that regular physical activity might offer protective benefits by modulating oxidative stress markers. Studies on glutathione metabolism further suggest that changes in GGT levels could be linked to altered glutathione recycling, indicating potential metabolic adaptations in response to exercise[20,21]. These findings highlight the need for further research to explore the long-term effects of exercise on oxidative stress and liver function across different populations.

Conclusion

Based on the data analysis and findings, the study concludes that high-intensity exercise significantly influences GGT levels among novice athletes. The observed rise in GGT levels is likely attributed to increased metabolic activity and oxidative stress induced by strenuous physical activity. However, the absence of dietary supplementation in the study cohort may have also played a role in the observed biochemical changes. Future studies should explore the interaction between exercise, dietary factors, and GGT regulation to better understand the underlying physiological mechanisms.

Recommendations

It is recommended that awareness sessions highlighting the health benefits of exercise be conducted to educate the public about its associated risks and advantages. Additionally, the development of exercise tracks in public parks should be prioritized to facilitate physical activity for the general population. To further promote physical and psychological well-being, qualified fitness experts should be appointed in educational institutions to guide students in incorporating suitable exercises alongside their academic activities. Moreover, considering the demands of high-intensity exercise, appropriate nutritional supplementation should be provided to enhance health benefits and mitigate potential risks associated with rigorous physical activity.

Conflicts of Interest

The author(s) have no conflicts of interest.

Acknowledgement

The principle authors acknowledge the cooperation of all the coauthors and participants for their support and time given to exercise intervention.

Funding

None.

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