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Modulation of the Renin-Angiotensin System: A Novel Exercise Analyzer Approach.

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Abstract

Background: The Renin-Angiotensin System (RAS) is a vital regulatory system that maintains electrolyte balance and blood pressure, playing a potential role in physical activity regulation. This study investigates the effects of moderate-intensity exercise on plasma renin levels using a novel, self-made exercise analyzer.
Methodology: An experimental research design was implemented. Healthy male students were randomly selected from the University of the Punjab (PU), Lahore, Pakistan. Participants were divided into two groups: the Control Group (CG) and the Experimental Group (EG), each consisting of five participants. Ethical approval was obtained from the University's ethical review board. The EG underwent an eight-week moderate-intensity exercise intervention. Plasma renin levels were measured pre- and post-intervention in both groups. Data analysis was conducted using SPSS (Version 26) with appropriate statistical tests applied.
Results: The study revealed that moderate-intensity exercise positively impacted plasma renin levels. For the EG, the pre-test mean (M) and standard deviation (SD) were 42.18±7.87, increasing to 54.00±11.22 post-intervention. In contrast, the CG showed pre-test values of 58.78±37.01, which rose to 87.92±51.44 post-intervention.
Conclusion: The findings suggest that moderate-intensity exercise leads to a significant increase in plasma renin levels, highlighting the physiological impact of exercise on the RAS.

Keywords

Renin-Angiotensin System, Plasma Renin Levels, Exercise Physiology, Moderate-Intensity Exercise, Self-Made Exercise Analyzer.

Introduction

The Renin-Angiotensin System (RAS) is a critical endocrine system responsible for maintaining homeostasis in the body, including the regulation of blood volume, arterial blood pressure, and electrolyte balance. This system relies on the interplay of various enzymes and hormones to achieve these functions efficiently[1-3].

Angiotensinogen, a plasma glycoprotein synthesized in the liver, is converted into angiotensin I by renin, an enzyme secreted by the juxtaglomerular cells of the kidney. Although angiotensinogen is consistently abundant in blood plasma, the production of angiotensin I is primarily regulated by the levels and activity of renin. Renin remains active in the blood for approximately 30 minutes, continuously converting angiotensinogen into angiotensin I. Angiotensin I, a peptide consisting of 10 amino acids, has a mild vasoconstrictive effect, which alone does not result in significant changes in blood circulation[4,5].

Angiotensin II, the active component of the RAS, exerts two primary effects: vasoconstriction and stimulation of aldosterone secretion from the adrenal glands. Aldosterone plays a crucial role in regulating electrolyte balance and blood volume[6-10]. The Renin-Angiotensin System (RAS) consists of two opposing pathways. The Classical Pathway involves the angiotensin-converting enzyme (ACE), angiotensin II (Ang-II), and angiotensin type 1 (AT1) receptors. Activation of this pathway promotes vasoconstriction, cell proliferation, organ hypertrophy, and sodium retention, contributing to various cardiovascular and renal pathologies. In contrast, the Counter-Regulatory Pathway, discovered in 2000, includes ACE2, angiotensin 1-7 (Ang 1-7), and the Mas receptor. Activation of this pathway induces anti-inflammatory, vasodilatory, antiproliferative, cardioprotective, and renoprotective effects, serving to counterbalance the detrimental actions of the classical pathway[7-10].

Gender differences also influence RAS responses to exercise. Maximal exercise tends to elevate plasma renin levels more significantly in women than in men[11]. Aerobic exercise has been shown to reduce total body fat and may slightly lower pulse pressure and heart rate. However, its impact on plasma renin levels remains inconclusive[12]. Studies suggest that exercise in hot and humid environments can lead to significant electrolyte and fluid loss through perspiration. This loss depletes extracellular fluid, reduces renal perfusion, and stimulates renin secretion as a compensatory mechanism. Physical activity also shifts blood flow toward active muscle tissues requiring increased oxygen consumption, further reducing renal perfusion and triggering sodium loss and renin secretion. Plasma renin levels tend to rise during and immediately after exercise but generally return to baseline within 6-12 hours of rest[8,13-19].

Given the significant role of RAS in maintaining physiological homeostasis, it is crucial to explore the effects of physical exercise on this system. To date, no human studies have specifically investigated the impact of moderate-intensity exercise on RAS. This gap in knowledge prompted the current research, which aims to examine the effects of moderate-intensity exercise on the RAS, providing valuable insights into its influence on various physiological functions.

Methodology

Study Design

This experimental research study aimed to evaluate the impact of moderate-intensity exercise on the renin-angiotensin system (RAS) of the body. The experimental research design included a randomized control trial with participants allocated to either an experimental group (EG) or a control group (CG). The intervention spanned eight weeks, involving a structured exercise protocol for the EG while the CG received no exercise intervention.

Ethics

Ethical approval for this study was granted by the Ethical Review and Research Board of the Department of Sports Sciences and Physical Education, University of the Punjab, Lahore, Pakistan (Ref No. 695/SPS). All participants were informed of the study objectives, procedures, potential risks, and benefits. Written informed consent was obtained before enrollment.

Setting
The study was conducted within the Department of Sports Sciences and Physical Education, University of the Punjab, Lahore, Pakistan, between 1st March 2024 and 28th May 2024. The exercise sessions and data collection processes were carried out under controlled conditions within the department's facilities.

Participants
The participants in this study were male students aged 18-22 years, selected based on specific inclusion criteria, including voluntary participation, the absence of chronic health conditions, and no ongoing medication use. A total of 30 participants were randomly assigned to two groups: 15 individuals were allocated to the experimental group (EG), and 15 to the control group (CG). The randomization process was carried out to ensure an equal chance of allocation to each group. Participants with chronic diseases or those currently taking medication were excluded from the study.

Variables
The primary variable of interest was the plasma renin level, measured to assess the impact of the exercise intervention. Other variables included demographic factors (age, weight, and height) and the exercise protocol adherence for the EG.

Data Sources/Measurement
A moderate-intensity exercise protocol was developed specifically for this study and administered to the EG for eight weeks. Sessions were conducted five days per week at 60-75% of Heart Rate Maximum (HRM) to maintain moderate intensity. HRM was calculated individually for each participant.

Plasma renin levels were measured using a chemiluminescence immunoassay (CLIA), a type of enzyme-linked immunoassay (ELISA). Blood samples (5-10 mL) were collected from participants' veins, typically from the back of the hand or the inside of the elbow. Samples were centrifuged to separate serum and stored at 2-8°C before analysis at the Test Zone Diagnostic Center (Registration ID: TZDC-0324-16510).

Bias
Efforts were made to minimize bias by randomizing participants into groups, standardizing the exercise protocol, and using validated laboratory techniques for plasma renin measurement. Potential confounders, such as salt consumption, medication use, and physical positioning during sampling, were controlled as per protocol.

Study Size
The sample size was calculated using G*Power statistical software to ensure adequate power to detect significant differences between groups. A total of 30 participants were enrolled, with 15 in each group.

Quantitative Variables
The primary quantitative variable was plasma renin level, reported in micro-international units per milliliter (nIU/mL). Normal reference values ranged from 4.4 to 46.1 nIU/mL in the upright position. Factors affecting renin levels, such as dietary salt intake, pregnancy, and diurnal variations, were documented for consistency.

Statistical Methods
Data were analyzed using SPSS version 26. Within-group comparisons (pre- and post-intervention) for the EG and CG were conducted using paired sample t-tests. Between-group differences in plasma renin levels post-intervention were analyzed using independent sample t-tests. Statistical significance was set at $p < 0.05$, and results were presented as mean ± standard deviation.

Results

A total of 30 participants were enrolled in the study, with 15 individuals allocated to the Control Group (CG) and 15 to the Experimental Group (EG). All participants completed the intervention without any dropout, ensuring consistent data collection for both pre-intervention and post-intervention assessments.

Table 1: Within group Pre-test and post intervention comparison of Plasma Renin Level.

Variables	Pre-Intervention Plasma Renin Level (uIU/Ml)	Post-Intervention Plasma Renin Level (uIU/Ml)	P-value
CG	58.78±37.01	87.92±51.44	0.624
EG	42.18±7.87	54.00±25.10	0.776

Values are given as Mean±SD
CG = Control Group, EG= Experimental Group
p<0.05 is considered statistically significant

In the within-group comparison (Table 1), plasma renin levels in the control group (CG) increased from pre-intervention (58.78±37.01 uIU/mL) to post-intervention (87.92±51.44 uIU/mL), but the change was not statistically significant (p = 0.624). Similarly, in the experimental group (EG), plasma renin levels increased from pre-intervention (42.18±7.87 uIU/mL) to post-intervention (54.00±25.10 uIU/mL), with this change also not reaching statistical significance (p = 0.776).

Table 2: Between Group comparison of EG and CG in term Plasma Renin Level.

Variable	Group	Mean±SD	Df	t	P-value
Pre-Intervention Plasma Renin Level (uIU/Ml)	CG	58.78±37.01	8	-.981	0.102
	EG	42.18±7.87			
Post-Intervention Plasma Renin Level (uIU/Ml)	CG	87.92±51.44	8	-1.325	0.040*
	EG	54.00±25.10			

CG = Control Group, EG= Experimental Group
p<0.05 is considered statistically significant

In the between-group comparison (Table 2), pre-intervention plasma renin levels were higher in the CG (58.78±37.01 uIU/mL) compared to the EG (42.18±7.87 uIU/mL), although this difference was not statistically significant (t = -0.981, p = 0.102). However, post-intervention plasma renin levels were significantly higher in the CG (87.92±51.44 uIU/mL) than in the EG (54.00±25.10 uIU/mL), with a significant difference observed (t = -1.325, p = 0.040).

Discussion

The findings of the present study demonstrate that moderate-intensity exercise positively impacts plasma renin levels. In the experimental group (EG), the pre-test mean and standard deviation were 42.18 ± 7.87, while the post-test mean and standard deviation increased to 54.00 ± 11.22. Conversely, in the control group (CG), the pre-test mean and standard deviation were 58.78 ± 37.01, which increased to 87.92 ± 51.44 in the post-test phase. These findings align with the results of previous research[3], which indicated that exercise causes a significant rise in plasma renin levels during and immediately after exercise, followed by a return to baseline levels within 6–12 hours of rest.

Research also highlights that components of the renin-angiotensin system (RAS) are acutely elevated during aerobic exercise, with moderate-intensity continuous exercise (MICE) causing a more significant increase in these components than high-intensity interval exercise (HIIE)[12]. A systematic review by Saghiv et al.[13] supports these findings, reporting that both submaximal and maximal exercise intensities lead to notable increases in plasma renin levels, with hormone levels returning to baseline post-exercise. These effects are influenced by variables such as age, gender, menstrual cycle, salt intake, posture, thermal stress, altitude, training level, and type of exercise.

Regarding demographic variables, changes in weight were observed in the study. For instance, in the pre-test phase, the CG had a mean weight of 60.80 ± 9.03, while the EG had a mean weight of 64.00 ± 7.18. In the post-test phase, the mean weight of the CG decreased to 58.36 ± 12.17, whereas the EG experienced a slight increase to 64.86 ± 9.57. Although these changes were not statistically significant, they align with findings from studies such as Alves et al.[14], which emphasize that physical activity positively influences the development of muscles, bones, and adipose tissue.

For example, a study by Zribi et al.[15] involving 98 children revealed that participants engaged in regular physical activity, such as basketball, exhibited greater bone and muscle growth than their sedentary counterparts. These results further underscore the importance of regular physical exercise for overall physiological development and health.

Conclusion

This study concludes that moderate-intensity exercise positively affects plasma renin levels, with significant increases observed in the experimental group post-intervention. In the control group, the increase in renin levels may be attributed to uncontrolled dietary and environmental factors. The findings suggest that moderate-intensity exercise activates components of the RAS, which can have physiological benefits. However, the study's limitations necessitate caution in generalizing these results.

Conflicts of Interest

The author(s) have no conflicts of interest.

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