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IMPACT OF MODERATE INTENSITY EXERCISE ON HEART EFFICIENCY AMONG FEMALES STUDENTS

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ABSTRACT

Study Background: Heart efficiency is a term that defines overall cardiovascular health. This Study aims to develop a comprehensive understanding of how exercise affects and facilitates the improvement in heart efficiency among females.

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Methodology of the study: An Experimental research design was used in this study. Female students were selected randomly from the University of the Punjab, Lahore. The sample size was 20, divided into a control group (CG) and an experimental group (EG). Each group was comprised of ten (10) Subjects. Ethical approval was obtained from the ethical review and research board of Punjab University. Subjects of the experimental Group underwent an 8-week moderate-intensity exercise intervention. An electrocardiogram ECG was recorded as a pre- and post-test. Thus, pre- and post-test data were analyzed by the Statistical Package for Social Sciences (SPSS version 26).

Results: The result indicates that there is a significant effect of moderate intensity exercise intervention on heart efficiency in terms of heart rate variability and resting heart rate, with the significant values of .001 and .002, respectively. The QRS complex remains unchanged before and after exercise intervention, with a significant value of 0.268, indicating no significant effect of exercise intervention on the QRS complex.

Conclusion: Based on the findings, the researcher concluded that there is a significant impact of moderate intensity exercise on heart efficiency in terms of heart rate variability and resting heart rate among females. However, QRS duration remains unchanged with exercise interventions.

Keywords : Heart efficiency, Heart rate variability,Resting heart rate,depolarization of heart(QRS complex) etc.

INTRODUCTION

The heart is a structure in the thorax, behind the sternum and resting on the diaphragm, that serves as an important pump in the circulatory system. The heart is predominantly myocardium and the distance from base to apex, width, and thickness of the heart are approximately 12 cm, 8.5cm, and 6 cm respectively. It has four chambers: the atria, to receive blood and the ventricles, which pump it out. A node called the sinoatrial, provides "beat" like pulsations causing blood to circulate through a wide network of blood vessels. Heart valves control blood flow in a single direction, ensuring the distribution of oxygen and nutrients required by organs for optimal performance (13).

Heart efficiency, often referred to as cardiac efficiency, is the ability of the heart to pump blood effectively, which is usually quantified by many parameters such as resting heart rate, stroke volume, ejection fraction, blood pressure, heart rate variability, sinus rhythm, Depolarization of the heart (QRS Complex), and Creatine kinase myocardial band CK-MB (1).

Physical activity, a cornerstone of fitness, fosters cardiovascular health through increasing muscle strength and promoting favorable physiological responses. It rapidly raises heart rate and blood pressure, but long-term physical activity produces a lower resting heartrate and less risk of developing the killer diseases. In this study, three parameters of the heart namely RHR, HRV and QRS complex are considered as primary concern for research.(2).

Regular cardiovascular and aerobic exercises, such as running, swimming, and

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cycling, lead to a lower resting heart rate (RHR), which is the number of beats per minute at rest. This reduction indicates improved heart efficiency, as the heart can pump more blood with fewer beats. Typically, a healthy adult's RHR ranges from 60 to 100 beats per minute, with a lower RHR reflecting better cardiovascular fitness. Consistent moderate exercise can reduce RHR to as low as 40 beats per minute, demonstrating enhanced heart function (3).

Heart rate variability (HRV) is the physiological phenomenon of variation in the time interval between consecutive heartbeats. It is measured by the variation in the beat-to-beat interval and is influenced by the autonomic nervous system. HRV serves as an essential indicator of autonomic function and cardiac health, reflecting the balance between the sympathetic and parasympathetic branches of the autonomic nervous system. Higher HRV generally indicates greater cardiovascular fitness and resilience to stress, while lower HRV can be a marker of stress and potential health issues (4).

Exercise positively influences heart rate variability (HRV), reflecting the autonomic nervous system's regulation of the heart. Higher HRV indicates better cardiovascular fitness and resilience to stress. Endurance training enhances parasympathetic (vagal) activity, increasing HRV and improving heart responsiveness to stressors. Regular exercise reduces overall stress responses by decreasing sympathetic nervous system activity, leading to a balanced autonomic nervous system and enhanced heart adaptability (5).

The QRS Complex represents the Depolarization of the heart, which refers to the process by which the cardiac muscle cells change their membrane potential, leading to the contraction of the heart muscle. This electrical activation begins in the sinoatrial (SA) node, the heart's natural pacemaker, and spreads through the atria, causing them to contract. The electrical impulse then travels to the atrioventricular (AV) node, down to the bundle of His, and through the Purkinje fibers, leading to the Depolarization and subsequent contraction of the ventricles. This coordinated electrical activity ensures the efficient pumping of blood throughout the body (7).

The QRS complex is a fundamental component of the electrocardiogram (ECG), representing the rapid Depolarization of the right and left ventricles of the heart. The duration and morphology of the QRS complex provide critical information about the electrical activity of the heart and can indicate the heart's efficiency. Generally, aerobic exercise tends to decrease QRS duration. This is attributed to enhanced cardiac conduction efficiency and more synchronized ventricular Depolarization and repolarization (6).

Among women, heart efficiency is also significantly enhanced with moderate-intensity activity. One study provided evidence that moderate-intensity physical activity was associated with significant reductions in RHR and increased HRV, both of which are strong indicators of autonomic function. In addition, moderate intensity exercise has been shown to be especially effective for enhancing QRS complex indices since it improves cardiac conduction capacity more efficiently with a lower workload than high-intensity exercises (14).

More recent studies have suggested that even moderate-intensity exercise can improve endothelial function, resulting in superior vascular health and ultimately enhanced cardiac performance. Similarly, such training also exerts a beneficial effect on the lipid profile - which would protect against atherosclerosis and therefore associated

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cardiac conditions, again improving overall heart efficiency (15).

Recent works have documented the wide range of favorable effects moderate intensity exercise has on the cardiovascular system, especially in females. For example, a meta-analysis by Laddu et al. (2020) indicates that moderate total work (i.e., exercise workload) can enhance cardiac efficiency, and decrease the prevalence of CVD in females (16).. This is corroborated by findings from the Women's Health Study, which revealed that moderate physical activity is associated with a 30% reduction in the risk of coronary heart disease (CHD)(17).

Furthermore, moderate-intensity exercise enhances myocardial perfusion and ventricular function, as demonstrated in a recent study that shows that women participating in regular moderate-intensity exercise had better myocardial oxygenation and left ventricular ejection fraction compared to their sedentary counterparts (18).

Given the specific physiological and hormonal differences in females, moderate-intensity exercise provides an effective and sustainable means to improve cardiac efficiency. This research focuses on RHR, HRV, and QRS complex as primary parameters to provide a comprehensive understanding of how moderate-intensity exercise influences heart health in women.

Studying the effects of moderate exercise on heart efficiency holds significant importance for individual and public health. Moderate exercise consistently demonstrates positive impacts on cardiovascular health, reducing the risk of heart disease and hypertension and enhancing overall heart function.

This understanding aids in crafting accurate recommendations for females to optimize their heart efficiency and reduce disease risk. Given the rising prevalence of heart diseases globally, research on moderate exercise's effects on heart efficiency becomes crucial for preventive strategies.

MATERIAL AND METHODS

Trial design:

The researcher has chosen the experimental design to explore the effect of modest exercise on cardiovascular efficiency. An experimental research study is a formal you want to explore the cause of something. It consists in varying one or more independent variable(s) and observing the effect(s) on a dependent variable adjusting, when necessary, for one or more confounding factors (8).

Participants

The data is collected on 20 female students of University of Punjab, Lahore in the age group of 18-22. The sample was not selected on purpose, and by reliable medical records their health status was guaranteed. A pre-test of an ECG electrocardiogram assessed their cardiac condition. All the participants were healthy and did not suffer from any cardiac condition. After completing the targeted population of 20 non-athlete female students, the researcher divided the population into two groups: Control and Experimental Group, each consisting of 10 participants. Then the researcher applied 08 weeks exercise protocol to the Experimental Group.

Intervention

An eight-week exercise protocol developed by Salam Tehseen Othman and Tehseen H. Bayram Temur (2018) was applied in this research (9).

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This training program consisted of walking, running, and phases of slow and then fast running, with distance and duration progressively increasing.
The formula 220-age measures intensity of exercise and 50% of that max HR is considered moderate intensity.

Cardiac assesment tests

Study was planned to see the impact of exercise on cardiac efficiency by undertaking pre- and post-intervention investigations with ECG as an investigative tool. Mainly, the study strived to evaluate quantitative (i.e., HRV and RHR) and finite characteristics such as Depolarization of heart QRS complex. HRV, an index reflecting fluctuations in the time intervals between successive heart beats, is a powerful marker of autonomic nervous system dynamics and global cardiac function. Resting heart rate (RHR) in beats per minute at rest as an indicator of cardiovascular fitness and efficiency An ECG waveform QRS complex is representative of the electrical activity that corresponds to ventricular Depolarization, and is essential in evaluating the heart's electrical conduction system.

Recording Electrocardiogram ECG

The hospital paramedic personnel recorded the electrocardiogram of all participants as pre- and post-cardiac efficiency. The ECG machine of speed 25mm comprised of 12 leads with the recording of 10 seconds used in this research. In the current investigation, Heart Rate Variability (HRV) was assessed using the Time Domain method by utilizing RR interval data extracted from ECG reports.

Statistical Methods

To examine the pre-intervention test and post-intervention test difference, the pre-test and post-intervention data were analyzed using the appropriate descriptive statistical tools (mean and standard deviation) and inferential statistical techniques (paired sample t-test and independent sample t-test) in the SPSS (Statistical Package for the Social Sciences) version 26.

RESULTS

The results of paired sample T test and Independent sample T test shows significant impact of exercise intervention on heart effiecinecy in terms of HRV and RHR while QRS complex remain unchanged results are given below :

		Mean	Std. Deviation	Confidence interval Upper	Lower	T	dt	one sided p-value	two sided p-value
Pair 1	RHR_PRE - RHR_POST	-10.00000	7.24185	-4.81949	-15.18051	-4.367	9	<.001	.002

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Pair 2	HRV_PRE HRV_POST	18.90000	9.75762.	25.88018	11.91982	6.125	9	< .001	< .001
Pair 3	QRS_pre - QRS_POST	2.80000	7.62744	8.25634	-2.65634	1.161	9	.138	.0276

Table 1 Paired sample T test showing the analysis of pre and post test of experimental Group of both parameters i.e, HRV,RHR & QRS complex

In the above table paired samples t-test results for three pairs of variables (RHR, HRV, and QRS duration) show that there is a statistically significant decrease in Resting ,Heart Rate (RHR) from pre- to post-intervention with a mean difference of -10.00 beats per minute (SD = 7.24, $p < .001$ for one-sided, $p = .002$ for two-sided), indicating a strong effect of the intervention on reducing RHR. There is also a statistically significant increase in Heart Rate Variability (HRV) with a mean difference of 18.90 units (SD = 9.76, $p < .001$ for both one-sided and two-sided), suggesting that the intervention significantly improves HRV. However, the change in QRS duration, with a mean difference of 2.80 milliseconds (SD = 7.63), is not statistically significant ($p = .138$ for one-sided, $p = .0276$ for two-sided), implying that the intervention does not have a significant effect on QRS duration.

Table 1.2 Independent Sample T test of pre and post test for HRV of EXG & CG

Measure	**Levene's Test for Equality of Variances**	**t-test for Equality of Means**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**
	F	Sig.	T	df	one sided p
HRV-PRE	1.571	.026	2.735	18	.013
HRV-POST	.880	.031	2.627	18	.015

In the above table both HRV_PRE and HRV_POST show statistically significant differences between the groups, as indicated by the p-values being less than .05. The mean differences for both HRV_PRE and HRV_POST are substantial and positive, indicating that one group consistently shows higher heart rate variability before and after the intervention.

Resting heart rate RHR :

Exercise interventions significantly impact resting heart rate. The value of significance in independent sample t test of pre and post test for resting heart rate RHR less then .05 which shows that there is significant mean difference in both pre and post value of RHR .RHR relatively reduced after exercise intervention which

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shows better heart efficiency.

Table 1.3 Independent Sample T test for QRS complex for pre and post test of CG and EG

Measure	**Levene's Test for Equality of Variances**	**t-test for Equality of Means**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**
	F	Sig.	T	df	one sided p
QRS-pre	1.714	.207	.128	18	.450
QRS-post	.090	.767	.024	18	.491

In the above table both QRS_PRE and QRS_POST show no statistically significant differences between the groups, as indicated by the p-values being greater than .05.The confidence intervals for both QRS_PRE and QRS_POST include 0, further supporting the lack of significant differences. The mean differences for both QRS_PRE and QRS_POST are not substantial, indicating that there is no significant impact before and after the intervention on the QRS complex between the groups.

DISCUSSION

The purpose of the present study was to describe if moderate intensity exercise is useful in increasing heart rate variability (HRV). There was an improvement between the experimental group pre- and post-training of p = 0.001 and p = 0.002 respectively, which indicates a substantial decrease in HRV levels after training. This observation highlights the beneficial effect of exercise on ANS modulation.

This idea is supported by Felipe and Oliveira (2020) who found a phenomenon of improved HRV in sedentary adult participants after participating in a 12-week aerobic training program. - Their results are also consistent with the outcomes observed in this study, further supporting that structured aerobic training is effective in enhancing HRV indices. The current study showed that RHR was significantly decreased in response to the constant exercise regimen, p = 0.001in the experimental group after training program. This re-emphasizes the positive effect of exercise on cardiovascular health through RHR reduction (10).

Also, Sandercock and colleagues [18] have reported that studies of characteristics pre disposing to paediatric exercise in the U.K. are lacking. (2021) also report HRV to be significantly increased during moderate intense exercise, due to an increase in vagal tones and decrease of the sympathetic one. This autonomic balance restoration, is much needed as it helps the body to better respond to stress and decrease chances of cardiac arrhythmias. In addition, Soares-Miranda et al. (2015) showed that HRV is inversely related to the incidence of sudden cardiac death, advocating for the clinical importance of increase in the HRV through habitual exercise (19,20).

The third week of this training protocol showed significant change on RHR (P value = 0.001) in experimental group post-training compared with that pre-training. This underscores the favorable role of exercise on cardiovascular wellness through

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lowering RHR. This is consistent with the result of a large systematic review by Krestin and Knapp in 2018. In their systematic control trial review, one of the other factors was the long-term interventions from studies like endurance exercise and yoga where they too sustain reliable reductions on heart rate, or further lead to a lower risk-of-death ratio across diverse populations. These findings highlight the potential cardiovascular benefits of physical activity (PA) and its role in decreasing risk for cardiovascular events. The reduction in RHR reported herein constitutes a quantifiable indicator of better cardiac health that can be attributed to formalized exercise regimens (11).

Furthermore, a prospective study by Lee et al. (2019) showed that the decrease of RHR over time was also associated with a lower risk for cardiovascular diseases in a large population-based study of middle-aged women. This provides additional evidence that sustained moderate-intensity exercise can have a long-term benefit on heart health and overall mortality (21).

The p-value for the QRS in the experimental Group was equal to 0.0276 and is greater than the level of significance, 0.05 indicating that there is no statistically significant difference in QRS after intervention. This would therefore imply that the exercise intervention did not have a significant impact on QRS complex duration among the study samples. Second, a study in Applied Physiology also reported that although exercise elicits an elevation of the heart rate and a concomitant decrease in RR interval on ECGs, the QRS width is normally unchanged in healthy subjects (12).

Furthermore, Achten and Jeukendrup (2003), have established that while HR and R-R intervals are sensitive to determinants of exercise intensity, QRS duration remains relatively unaffected by all determinants of exercise intensity such as training status or ergometer resistance unless there is an underling cardiac pathology. This preservation of QRS duration is believed to be due to the inherent robustness of the intrinsic conduction system of the heart, which is not substantially disturbed during moderate-intensity exercise in health. A review by Franklin et al. (2018) also reports that exercise predominantly modifies heart rate variability and RHR, however it has little influence on the duration of the QRS complex which is in line with our results (22).

In conclusion, the present results support a marked beneficial influence of moderate-intensity exercise on HRV and RHR that point clearly toward improvement in autonomic function and cardiovascular health. Although the duration of QRS complex did not change, already existing literature has reported that exercise has more effect on other cardiac parameters than on this one. Regular lipidic exercise is still a classical approach to improve the cardiovascular health and reduce heart diseases, especially in females.

Conclusion

Based on the findings, the researcher concluded that there is a significant impact of moderate intensity exercise on heart efficiency in terms of heart rate variability and resting heart rate among females. However, QRS duration remains unchanged with exercise interventions. This study provides valuable insights to improve heart efficiency and maintain cardiovascular health with the help of exercise.

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