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LOW, MEDIUM, AND HIGH INTENSITY TRAINING EFFECTS ON LDL-C LEVELS IN AMATEUR FOOTBALL PLAYERS

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Abstract

High-level low-density lipoprotein cholesterol (LDL-C) is a primary risk factor for cardiovascular disease, and exercise training is recognized as an effective non-pharmacological intervention for lipid management. Nevertheless, the optimal exercise intensity for increasing LDL-C remains unclear. This research sought to evaluate the impact of low, medium, and high-intensity exercise training on LDL-C levels in amateur football players and to analyze the dose-response relationship among the different exercise intensities in reducing LDL-C magnitude. A pre-test/post-test experimental design was used, and 80 male amateur football athletes aged 18-25 years were randomly divided into four groups, namely Low Intensity, Medium Intensity, High Intensity Training Group, and Control Group. All experimental groups underwent a 12-week training intervention, with four sessions held weekly, and intensity was continuously monitored through heart rate telemetry. Baseline and post-intervention levels of LDL-C were measured. Homogeneity of the groups was confirmed at baseline before the intervention. After 12 weeks of the training program, statistically significant differences in LDL-C were found in all three experimental groups, with the magnitude of improvement increasing with exercise intensity. The high-intensity training group had the most significant reduction, followed by the medium- and low-intensity groups, respectively. In contrast, the control group showed no meaningful variations in LDL-C levels during the study, indicating that lipid levels did not change in the absence of exercise intervention. The findings provide empirical data to inform the optimization of exercise prescription guidelines in the management of lipid profiles.

Keywords: Low-Intensity Training; Medium-Intensity Training; High-Intensity Training; LDL-C; Amateur Football Players.

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Introduction

The major cause of mortality in the entire world is cardiovascular diseases (CVD), which claim around 17.9 million lives every year, as reported by the World Health Organization (WHO, 2021). Among the different risk factors that can be modified, high levels of low-density lipoprotein cholesterol (LDL-C) have been found to be the major pathogenic causative factor in the formation and progression of atherosclerosis (Ference et al., 2017). LDL-C, also known as bad cholesterol, facilitates deposits of lipid plaque in the arterial walls, which causes dysfunction of the endothelium, loss of vascular compliance, and risk of myocardial infarction and stroke (Mach et al., 2020). The clinical importance of LDL-C control has been well-established, and epidemiological studies revealed that a 1 mmol/L decrease in LDL-C levels is associated with a proportional 20-25% decrease in major cardiovascular events (Silverman et al., 2016). This has led to the identification and adoption of efficient non-pharmacological mechanisms of LDL-C modification, becoming a priority for the broader health of society.

The use of physical activity and structured exercise training is considered one of the fundamental therapeutic measures of cardiovascular risk reduction, and especially their lipid-modifying effects (Pedersen & Saltin, 2015). Regular physical activity is a core element of primary and secondary prevention of dyslipidemia that is recommended to be used jointly by the American Heart Association and the American College of Cardiology (Grundy et al., 2019). Nevertheless, even though an inverse relationship between the levels of physical activity and the cardiovascular mortality is well established, the optimal exercise prescription parameters, i.e., the intensity of the exercise, to maximize the LDL-C decrease, are not sufficiently defined. Conventional exercise prescriptions have focused on moderate-intensity continuous training, but recent findings indicate that more vigorous exercise regimens can have better cardiometabolic effects (Weston et al., 2014). The implications of this response, which depends on the intensity, are important in the prescription of exercises, especially in populations in which time-saving interventions might help improve adherence and compliance.

The physiological processes that underlie the effects of exercise on lowering LDL-C are complex and intensity-dependent. Regular exercise improves the operation of lipoprotein lipase, which is an important enzyme that is involved in breaking down fat-rich lipoproteins and the subsequent removal of LDL-C in the bloodstream (Mann et al., 2014). In addition, exercise training enhances the expression of hepatic LDL receptors, which increases the wastage and uptake of circulating LDL particles through the receptor (Wang and Xu, 2017). Higher intensity of exercise has been shown to have a greater effect on these enzymatic and receptor-mediated pathways, and this may be the reason behind the observed dose-response relationship between the intensity of exercise and lipid improvements (Kraus et al., 2002). In addition, high-intensity exercise has been linked to increased post-exercise energy expenditure, increased mitochondrial biogenesis, and increased insulin sensitivity, which are all indirect factors leading to desirable lipid profile changes (Gibala et al., 2012).

Although the evidence about the importance of exercise as a suitable intervention in the management of LDL-C is increasing, there still remain considerable knowledge gaps in the area of the comparative effectiveness of various training intensities. Past studies have produced mixed results, most of which are due to methodological heterogeneity; the participants varied in attributes and various forms of intervention duration and intensity measurement (Kelley and Kelley, 2006). Some researchers have found better lipid effects with high-intensity interval training than moderate-intensity continuous training (Ramos et al., 2015); however, others have not established any significant intensity-dependent differences (Shepherd et al., 2013). These conflicting results highlight the necessity of carefully managed, sufficiently powered randomized studies that systematically compare the intensity of control levels in one experimental design and, as a result, reduce inter-study variation and allow making more conclusive conclusions about the dose-response relationship.

Another important criterion in the study of lipids in exercise is the choice of a suitable study population. Football players, who are also amateurs, are a perfect group to study the effect of exercise intensity on LDL-C since the athletes have a normalized physical activity, are familiar with established training regimens, and can likely exhibit quantifiable physiological changes over comparatively brief interventions (Bangbo et al., 2006). Amateur football players are involved in sport-specific training on a regular basis, although often they have less extreme physiological profiles in comparison to professional ones, making them closer to the physically active general population (Hoff and Helgerud, 2004). More so, the homogeneity provided by clearly defined inclusion criteria, such as age restriction, male gender, and no pre-existing mental illness, among others, boosts internal validity and minimizes the chances of the influence of confounding factors on the actual intervention effect.

Dera Ismail Khan, Pakistan, is situated in a geographical and cultural context that gives the current exploration another sense of importance. There has been a gradual rise in lifestyle diseases and changes in eating habits that are typical of nutritional modernization in the region, which leads to the development of a burden of dyslipidemia and cardiovascular risk factors among young adults (Askari et al., 2025; Jafar et al., 2005). Although this epidemiological shift has occurred, there is a paucity of research studies to investigate the effectiveness of structured exercise programs in Pakistani groups; most of the available information is simply extrapolated to the Western cohorts, which have a different genetic, dietary, and lifestyle makeup. This knowledge gap is especially strong when it comes to the population of amateur athletes in South Asian contexts, where the cultural aspect, training, and environmental constraints can affect the exercise response (Arif et al., 2018) and lipid metabolism in a manner that current literature has failed to address (Misra et al., 2018). As such, region-specific studies are necessary in order to inform the evidence-based exercise recommendations based on the peculiarities of South Asian populations (Saeed et al., 2025).

The theoretical framework that will be used in this investigation is based on the known physiological principles of adaptation to exercise and metabolism of lipids. Conceptual basis of hypothesizing intensity-dependent LDL-C reductions is the dose-response paradigm, which assumes that physiological adaptations rise in direct proportion to the intensity of exercise stimuli (Garber et al., 2011). Such a framework is embraced by the exercise threshold theory, which proposes that background levels must be surpassed to generate any lipoprotein changes with increasing intensities, giving rise to an ever-brighter response until plateau effects emerge (Earnest et al., 2013). The current research allows testing all three theoretical propositions empirically and helps to fine-tune the evidence about the intensity thresholds to optimize lipids and thus helps to adjust the existing knowledge on this matter.

Method and Material

Research Design

The research had an experimental design that was designed as a pre-test and post-test, where three experimental groups (Low, Medium, and High Intensity Training) and a control group (CG) were used. The groups were first of all assessed at baseline (pre-test) of the LDL-C level before the intervention and then after the completion of the corresponding training protocols. Such a design allowed not only the comparison of within-group changes over time but also between-group differences, thus allowing the assessment of the difference in the effects of different exercise intensities on LDL-C levels.

Participants

The sample used in this study comprised 160 amateur football players from seven football clubs in Dera Ismail Khan. Eligibility criteria were limited to male amateur players who are between 18 and 25 years old and whose medical history is without any prior medical conditions to avoid homogeneity and interference of confounding factors. Based on the Cochran formula to determine finite population size, the sample size of 80 participants was found to be the required sample size. To ensure proportional representation, the sample was allocated across the seven clubs in proportion to each club's number of players, thereby increasing the generalizability and representativeness of the findings. They are distributed as follows:

Table 1. Distribution of Sample Size of the Sample Football Clubs

Club	Total Players	Proportion of Total Population	Sample Size per Club
Club A	25	25/160 = 15.6%	80 × 15.6% ≈ 12
Club B	30	30/160 = 18.75%	80 × 18.75% ≈ 15
Club C	20	20/160 = 12.5%	80 × 12.5% ≈ 10
Club D	35	35/160 = 21.875%	80 × 21.875% ≈ 18
Club E	15	15/160 = 9.375%	80 × 9.375% ≈ 7
Club F	25	25/160 = 15.6%	80 × 15.6% ≈ 12
Club G	10	10/160 = 6.25%	80 × 6.25% ≈ 6
Total	**160**	**100%**	**80**

Participant and Group Selection

The Physical Activity Readiness Questionnaire (PAR-Q) was conducted before randomization to determine the medical preparedness of all 80 respondents. After measuring LDL-C at baseline, the players were randomly assigned to two primary groups, i.e., "A" Group (Control Group) (20 players) and "B" Group (Experimental Group) (60 players).

The experimental group was further divided into three subgroups of 20 players each: Group I (Low Intensity Training Group), Group II (Medium Intensity Training Group), and Group III (High Intensity Training Group). The distribution was a balanced and systematic one, with the groups having 20 amateur football players each to investigate the LDL-C response to various training intensities.

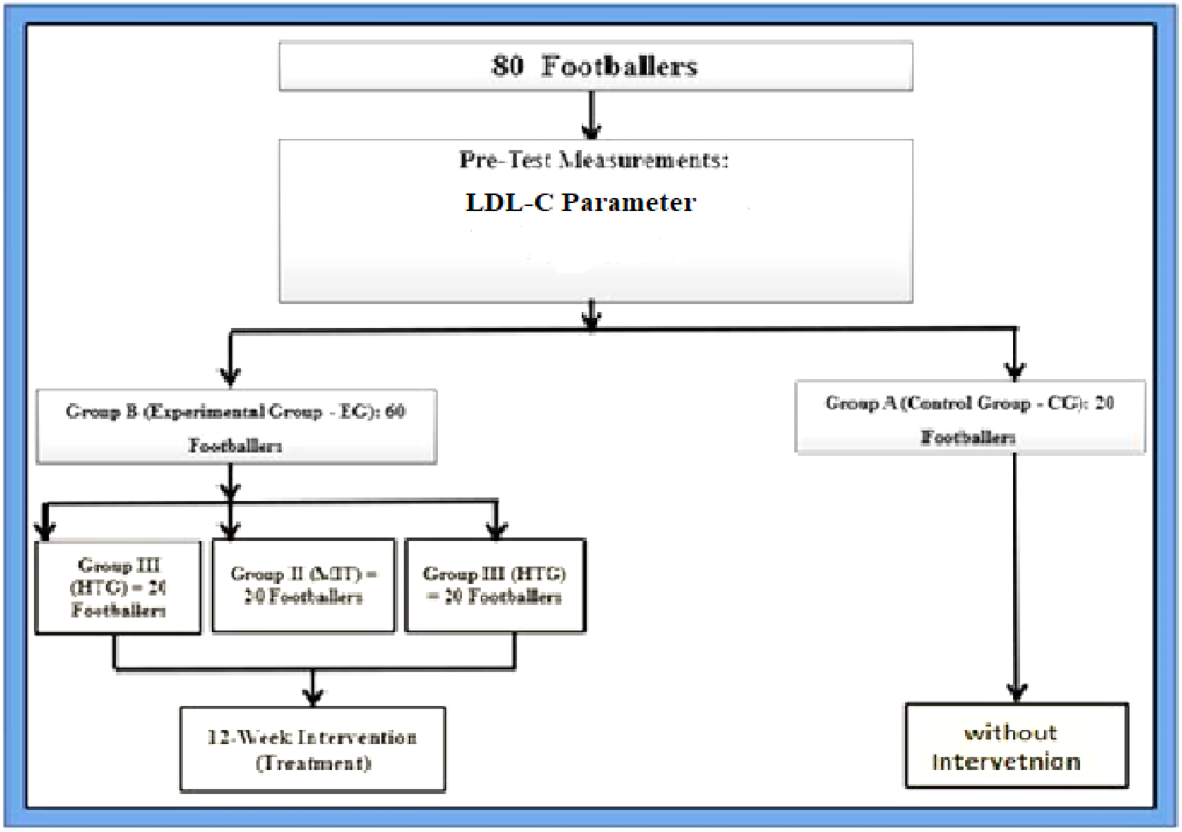

Figure 1.

Formulation of Exercise Protocol.

The intervention associated with exercise lasted 12 weeks, and all three experimental groups underwent a structured training programme of four sessions a week on Mondays, Tuesdays, Thursdays, and Fridays. It also began with a standardized warm-up which consisted of dynamic stretching exercises such as toe touches, side reaches, thigh hugs, and shoulder stretching, but the duration was different depending on the intensity level of the particular group.

Low Intensity Training Protocol.

The Low Intensity Training Group (LIT) exercised at a constant work rate of 40-50% of their maximum heart rate, which was continuously monitored with heart rate monitors. The session plan incorporated the use of a treadmill or stepper machine to take 12 minutes of walking, peddling on the machine; 6 minutes sitting on the wall supported by the sit-ups and push-ups; 13 minutes of walking; and 7 minutes of jogging. The participants were given one minute of rest after every exercise that had been done, and this added up to five minutes of rest. The duration of the sessions gradually rose to 65 minutes in the first three weeks and then 70 minutes in the fourth, fifth, sixth weeks, and finally 75 minutes in the seventh, eighth weeks, to make sure of a gradual change in the amount of training.

Medium Intensity Training Protocol.

Medium Intensity Training (MIT) was trained at 60-70% of maximum heart rate, whereby the intensity was strictly observed. The workout plan involved taking half a mile of walking for 7 minutes, riding one mile on a bicycle for 8 minutes, running half a mile for 6 minutes, and jumping rope for 5 minutes. There were 30 seconds of rest between exercises; the total time of rest per session was two minutes. The overall time was planned so as to commence 40 minutes in the first three weeks, up to 45 minutes in the fourth, fifth, and sixth weeks, and finally 50 minutes in the final two weeks to meet the rising fitness of the participants.

High Intensity Training Protocol.

High Intensity Training (HIT) was exercised at 80-90 percent of maximum heart rate, and those exercises were strictly monitored during every session. The protocol involved mountain climbers for 6 minutes, push-ups for 4 minutes, burpees and planks for 5 minutes, and skipping rope for 5 minutes. There was a short rest between exercises for 30 seconds and a maximum rest of 30 seconds. The length of the sessions was progressive and started with 25 minutes in the first four weeks and then proceeded to 31 minutes in weeks 5-8, and finally, 37 minutes in weeks 9-12, according to the increased intensity and challenge of the protocol, and proper physiological adjustment.

S.No	Parameters	Test Administered	Measurement Units
1	LDL-C	Blood test	mg/dl

Results

Part (A): Data Normality Tests

Table 2. LDL-C

			Kolmogorov-Smirnov[a]			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
LDL-C	LIT	Pre-test	.165	20	.157	.958	20	.513
LDL-C	LIT	Post-test	.126	20	.200*	.967	20	.681
LDL-C	MIT	Pre-test	.197	20	.040	.954	20	.425
LDL-C	MIT	Post-test	.126	20	.200*	.967	20	.681
LDL-C	HIT	Pre-test	.207	20	.024	.949	20	.353
LDL-C	HIT	Post-test	.187	20	.066	.956	20	.472
LDL-C	CG	Pre-test	.202	20	.031	.944	20	.286
LDL-C	CG	Post-test	.192	20	.051	.949	20	.351

Low Intensity Training (LIT), Medium Intensity Training (MIT), High Intensity Training (HIT), Control Group (CG)

Table 2, as presented, based on the results of the Shapiro- Wilk test, the p-value of all groups (Low, Medium, High Intensity Training, and Control) at the pre-test and post-test is higher than 0.05. The Shapiro-Wilk test is the best-suited test when the sample size of each group is less than 50 (sample size of either group is n=20), meaning that the data of all conditions follow the normal distribution.

$H_0 1$: There is no statistically significant change in the LDL-C parameter of Experimental Groups I (Low Intensity Training), Experimental Groups II (Medium Intensity Training), Experimental Group III (High Intensity Training), and Control Group before the training Program.

Table 3. ANOVA

LDL-C Pre					
	N	**Mean**	**Std. Deviation**	**F-value**	**p-value**
LIT	20	109.300	1.341		
MIT	20	109.250	1.292		
HIT	20	109.200	1.281	.050	.985
CG	20	109.350	1.268		
Total	80	109.275	1.272		

According to the results of ANOVA of LDL-C pre-test results: F=.050 p=.985, which is larger than .05. Thus, we cannot reject the null hypothesis (H01) that proves no significant differences between the four groups at baseline.

$H_A 2$: There is a statistically significant change in the LDL-C parameter of Experimental Groups I (Low Intensity Training), Experimental Groups II (Medium Intensity Training), Experimental Group III (High Intensity Training), and Control Group after the training Program.

Table 4 (a). Multiple Comparisons

LDL-C Post					
	N	**Mean**	**Std. Deviation**	**F-value**	**p-value**
LIT	20	107.900	1.372		
MIT	20	106.750	1.446		
HIT	20	104.950	1.468	35.921	.000
CG	20	109.400	1.313		
Total	80	107.250	2.137		

The one-way ANOVA showed that the post-test LDL-C levels in the three experimental groups and the control group differed significantly (F = 35.921, p = .000). Based on this, it is seen that the alternative hypothesis (HA10) is accepted, which states that the different levels of training had a different effect on LDL-C levels. Results of the mean values show a gradual decrease with training intensity, with the high intensity group having the lowest LDL-C (M = 104.95), followed by medium intensity (M = 106.75), low intensity (M = 107.90), and the control group with the highest values (M = 109.40). These results support the effectiveness of intensive exercise training in the regulation of lipid profiles.

Table 4 (b): Multiple Comparisons

Dependent Variable: LDL-C Post						
Tukey HSD						
(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
LIT	MIT	1.150	.443	.054	-.014	2.314
	HIT	2.950*	.443	.000	1.785	4.114
	CG	-1.500*	.443	.006	-2.664	-.335
MIT	LIT	-1.150	.443	.054	-2.314	.014
	HIT	1.800*	.443	.001	.635	2.964
	CG	-2.650*	.443	.000	-3.814	-1.485
HIT	LIT	-2.950*	.443	.000	-4.114	-1.785
	MIT	-1.800*	.443	.001	-2.964	-.635
	CG	-4.450*	.443	.000	-5.614	-3.285
CG (Without Protocol)	LIT	1.500*	.443	.006	.335	2.664
	MIT	2.650*	.443	.000	1.485	3.814
	HIT	4.450*	.443	.000	3.285	5.614

The post-hoc analysis in terms of the Tukey HSD was carried out to find particular specific alterations related to the groups in the wake of the prominent ANOVA outcome. The results showed that the low and the medium intensity groups showed no significant difference in the results (p =.054), but both showed a significantly lower level of LDL-C when compared to the control group (p <.01). It is important to note that the high intensity exercise protocol presented the strongest effect, giving substantial LDL-C reductions relative to the rest of the groups including medium (p = .001) and low intensity (p = .000) protocols. These findings provide a strong dose-response relationship, as it is proven that the results of high or low training intensity are linked to the gradual increase in LDL-C levels.

H_A 3: There is a statistically significant effect between pre and post-test of LDL-C parameter of Experimental Groups I (Low Intensity Training), Experimental Groups II (Medium Intensity Training), and Experimental Group III (High Intensity Training).

Table 5. Paired Samples Statistics

		N	Mean	Std. Deviation	t-value	p-value
Pair 1	LDL-C Pre LIT	20	109.300	1.341	10.510	.000
	LDL-C Post LIT	20	108.150	1.424		
Pair 2	LDL-C Pre MIT	20	109.250	1.292	18.380	.000
	LDL-C Post MIT	20	106.550	1.276		
Pair 3	LDL-C Pre HIT	20	109.200	1.281	20.876	.000
	LDL-C Post HIT	20	104.950	1.468		

The paired samples t-test showed statistically significant post-test LDL-C reductions in all three experimental groups as compared to the pre-test. The low-intensity group showed considerable drop (t = 10.510, p = .000), the medium-intensity group showed a more significant drop (t = 18.380, p =.000) and the high-intensity group had the biggest drop (t = 20.876, p = .000). These results affirm that all the training levels were effective in reducing LDL-C, with the degree of reduction gradually rising as the intensity of exercise rose.

H_0 4: There is no statistically significant effect between pre- and post-test of the LDL-C parameter of the Control Group.

Table 6. Paired Samples Statistics

		N	Mean	Std. Deviation	t-value	p-value
Pair 1	LDL-C Pre CG (Without Treatment)	20	109.350	1.268	-1.000	.330
	LDL-C Post CG (Without Treatment)	20	109.400	1.313		

The control group paired samples t-test showed that there was no statistically significant difference in LDL-C levels between pre-test (M = 109.35) and post-test (M = 109.40), t-value = -1.000, p-value = .330. The p-value is greater than the .05 threshold of significance, which proves that the null hypothesis can be accepted, and the LLD-C levels did not change during the study period without the use of any exercise intervention.

Findings

The results of a one-way ANOVA performed on the baseline levels of LDL-C showed that there was no statistically significant difference between the three experimental conditions and the control condition before the intervention (F =.050, p =.985). Thus, the null hypothesis (H01) is accepted, and it was proved that the four groups were similar at the beginning and that any further change could be explained by the corresponding training programmes.

It was found that the post-test LDL-C level was statistically different between the experimental group and the control group (F = 35.921, p = .000). As a result, the alternative hypothesis (HA10) is accepted. The average data shows the gradual decrease in the LDL-C according to the training intensity, and the high intensity group shows the best results, which proves the difference in the efficacy of the exercise regimes.

The results indicated statistically significant differences between the LDL-C levels of the Low Intensity (t = 10.510, p = .000), Medium Intensity (t = 18.380, p = .000), and High Intensity (t = 20.876, p = .000) over the experimental groups of the various levels of intensity. On the contrary, there was no significant difference in the control group (t = -1.000, p = .330), which ensured the stability of LDL-C in the untreated group. The results provide conclusive evidence of the effectiveness of all three levels of training in lowering LDL-C, with the stability of the control group confirming that the changes were due to the exercise programmes.

Conclusion

The paper has conclusively shown that exercise training of different intensities has necessary effects in lowering LDL-C. Homogeneity between groups at baseline was a guarantee that the changes after the interventions could be assigned to the protocols. Large post-test events were observed, with intensities giving higher LDL-C reductions. A significant decrease was measured by paired comparisons in all the experimental groups, and no changes were seen in the control group. These results provide a definite dose-response correlation and confirm the effectiveness of exercise training based on intensity in improving the lipid profiles.

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