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Effect of High Intensity Training Protocol on Alkaline Phosphatase (ALP): A Controlled Study

Muhammad Bakhtiar[1]	Kabir Jan[2]
Ghulam Mustafa[3]	Shamshaid Ahmed[4]

[1] Principal Pakhtunkhwa Schooling System Peshawar.
[2] Director Physical Education, Govt College of Technology Kohat Road Peshawar
[3] PhD Scholar Department of Sports Sciences and Physical Education, Gomal University Dera Ismail Khan, KP, Pakistan
[4] PhD scholar, Department of Sports Sciences and Physical Education, University of Haripur, Haripur, KPK.
shamshaidwarraich956@gmail.com
Corresponding author: sportsscientist246@gmail.com

Abstract

This controlled study investigated the effects of eight-week high-intensity training protocol on alkaline phosphatase levels in male football student-athletes. A pre-test and post-test research design was employed, comprised 120 participants, and selected 60 participants (50% of the total) from club-level football athletes. These participants were randomly assigned an experimental group, which provided the high-intensity training program, on the other hand the control group, which didn't participate in the training program. Pre measurements of alkaline phosphatase were collected at the start, and follow-up assessments were conducted at the end of the eight-week

duration to evaluate changes. The training program was structured 8 weeks high-intensity training protocol with different week and different intensities, to progressively increase in intensity. Results of current research indicated a significant reduction in alkaline phosphatase levels in the experimental group post-training ($p < .001$), while not significant difference was showed in the control group ($p > .05$). These findings provide the importance of incorporating high-intensity training protocols in athletic programs to enhance alkaline phosphatase levels.

Keywords: high-intensity training protocol, alkaline phosphatase, football student-athletes.

INTRODUCTION

Alkaline phosphatase is an enzyme found in several tissues in human the body, with particularly main concentrations in the liver, bones, bile ducts, and placenta. Alkaline phosphatase (ALP) plays a vital role in the hydrolysis of phosphate esters, which is necessary for dephosphorylation processes critical in metabolism and signal transduction. Elevated Alkaline phosphatase levels are often indicative of increased liver dysfunction or bone turnover making it a valuable biomarker in clinical diagnostics (Farrell et al., 2021). The enzyme's activity is importance in the mineralization of teeth and bones, so its significant presence in osteoblasts. Research has indicated that ALP levels can be influenced out various factors, includes disease states, diet, age, and physical activity (Roberts et al., 2023).

Exercise/training is well-documented that influence much biochemical markers, reflecting its systemic effect on the body. Regular exercise induces physiological improvement that most beneficial to our cardiac, musculo-skeletal, and metabolic health of an individual. Therefore, endurance training program typically leads to reductions in inflammatory markers and beneficial in lipid profiles, whereas resistance training program is known to improve muscle hypertrophy and strength of the participants (Chmelo et al., 2022). Physically training-induced changes in biochemical markers also extend to enzymes and hormones that regulation of metabolism and energy production. Recent research studies have indicated that both acute and chronic training intervention can modulate the levels of enzymes such as creatine kinase, lactate dehydrogenase, and ALP (Goodpaster et al., 2023). These changes

indicative of the metabolic demands placed on the body during participate in exercise and the subsequent recovery and adaptation.

High-intensity training Program (HITP) protocols, including high-intensity interval training program (HIITP) and sprint interval training program (SITP), have gained popularity for their efficiency in enhance cardiovascular and metabolic fitness. HITP involves short bursts of intense exercise followed by periods of low-intensity recovery or rest. This approach has been indicating to improve aerobic and anaerobic capacity of an individual, and increase mitochondrial density, and improve insulin sensitivity more effective than moderate-intensity training (MIT) (Gibala et al., 2020). The mechanisms underlying these improvements include increased oxidative stress, which triggers adaptive responses in muscle-cells, and its enhanced cardiac output. Similarly, HITP can lead to significant improvements in our body, reducing extra fat and developing lean muscle mass (MacInnis & Gibala, 2017). The time efficiency of HITP protocols makes them an attractive option for every single individual with busy lifestyles seeking substantial health benefits with minimal time commitment.

Despite the well-documented benefits of HIT on various health parameters, the specific effects on ALP levels remain underexplored. Understanding how high-intensity training influences ALP can provide insights into the broader metabolic and skeletal adaptations induced by such exercise regimes. Given that ALP is a marker for both bone and liver function, investigating its response to HIT can reveal potential benefits or risks associated with these tissues. Previous studies have primarily focused on moderate-intensity exercise and its impact on ALP, showing mixed results (Robinson et al., 2021). However, the unique physiological demands of HIT, characterized by repeated high-intensity efforts, could produce different outcomes. This study aims to fill this gap by examining the effects of a controlled HIT protocol on ALP levels, thereby contributing to a more comprehensive understanding of the biochemical responses to high-intensity exercise.

OBJECTIVES

1. To compare the alkaline phosphatase (ALP) of experimental and control group before the intervention in Male football Students Athletes

2. To compare the alkaline phosphatase (ALP) of experimental and control group after the intervention in Male football Students Athletes
3. To compare the alkaline phosphatase (ALP) of experimental group before and after the training intervention
4. To compare the alkaline phosphatase (ALP) of Control Group before and after the training intervention

HYPOTHESES

1. H_0 There is no difference in alkaline phosphatase (ALP) of experimental and control group before the intervention in Male football Students Athletes
2. H_A There is significant difference in alkaline phosphatase (ALP) of experimental and control group after the intervention in Male football Students Athletes
3. H_A There is significant difference in alkaline phosphatase (ALP) of experimental group before and after the training intervention
4. H_0 There is no significant in alkaline phosphatase (ALP) of Control Group before and after the training intervention

LITERATURE REVIEW

Alkaline phosphatase (ALP) is a crucial enzyme linked to bone health, predominantly expressed in osteoblasts and playing a pivotal role in bone mineralization (Whyte, 2018). ALP facilitates the hydrolysis of phosphate esters at an alkaline pH, which is essential for providing phosphate ions for hydroxyapatite formation, the mineral component of bone. Elevated levels of ALP are often indicative of increased osteoblastic activity and bone turnover, seen in conditions such as bone fractures, Paget's disease, and certain types of cancers (Eastell et al., 2016). Conversely, low ALP levels can suggest hypophosphatasia, a rare genetic disorder characterized by defective bone mineralization (Mornet, 2021). Recent studies have explored the utility of ALP as a biomarker for bone health in various populations. For instance, research involving elderly individuals has shown that higher ALP levels are correlated with increased bone density and reduced fracture risk, underscoring its potential as a marker for bone health monitoring (Hoffmann et al., 2020).

Additionally, ALP's role extends beyond bone, with implications for liver and kidney function, making it a versatile marker in clinical biochemistry (Reid et al., 2020).Exercise is widely recognized for its

beneficial effects on bone metabolism, enhancing bone density, and reducing the risk of osteoporosis (Kohrt et al., 2018). Mechanical loading through weight-bearing exercises stimulates bone formation by promoting osteoblastic activity and increasing the release of growth factors such as insulin-like growth factor-1 (IGF-1) (Liu-Ambrose et al., 2019). Resistance training, in particular, has been shown to be effective in improving bone mass and strength, especially in postmenopausal women and older adults (Mustafa et al., 2022; Marques et al., 2018). Another study by Mustafa et al. (2024) found that strength and resistance training improved the serum phosphorus levels in male footballers after 12 weeks of intervention. Aerobic exercises like running and high-impact sports have been associated with increased bone turnover and enhanced bone mineral density (BMD) (Nikander et al., 2019). The mechanotransduction process, wherein mechanical forces are converted into biochemical signals, plays a critical role in this context. Studies have indicated that even moderate-intensity exercises can positively impact bone health by reducing markers of bone resorption and increasing bone formation markers (Martyn-St James & Carroll, 2017).

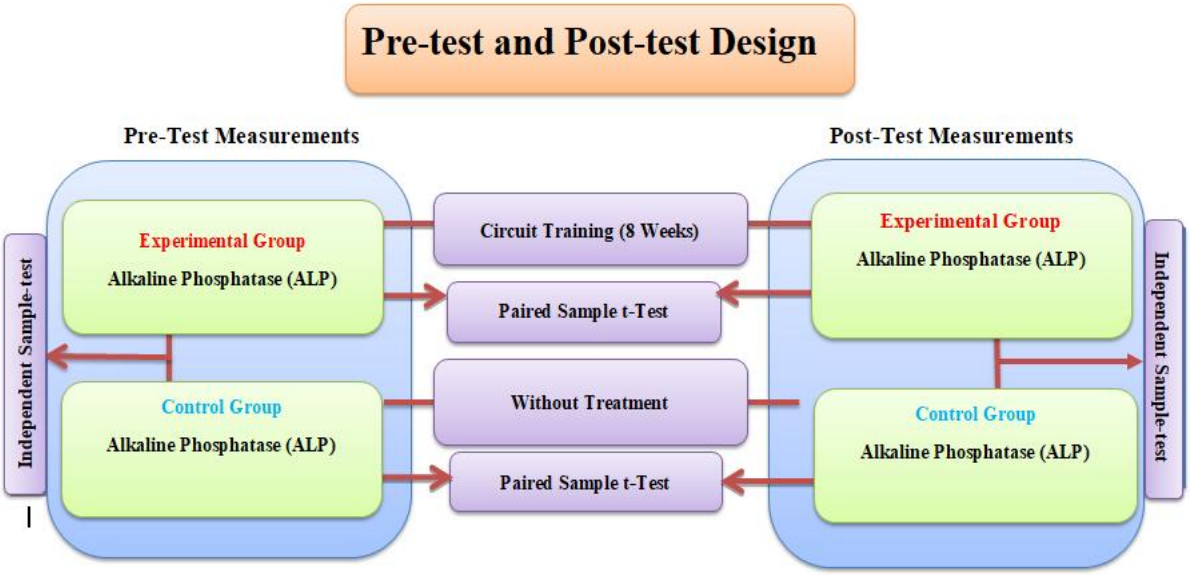
High-intensity training (HIT), characterized by short bursts of intense activity followed by rest or low-intensity periods, has gained popularity for its efficiency and health benefits (Gibala et al., 2020). HIT has been shown to influence various biochemical markers, including those related to bone metabolism. Research indicates that HIT can increase bone formation markers such as osteocalcin and ALP while reducing bone resorption markers like C-terminal telopeptide (CTX) (Moran et al., 2019). The physiological mechanisms underlying these effects include increased mechanical loading and metabolic stress during high-intensity exercise, which stimulate osteoblastic activity and enhance bone turnover (Scott et al., 2019). HIT also promotes the release of anabolic hormones such as growth hormone and IGF-1, further contributing to bone health (Larsen et al., 2018). A study by Francois and Little (2017) found that eight weeks of HIT improved markers of bone metabolism in young adults, suggesting its potential in bone health maintenance and improvement. HIT has been associated with favorable changes in other health markers, including improved cardiovascular fitness, insulin sensitivity, and body composition (MacInnis & Gibala, 2017). These systemic health benefits indirectly support bone health by

reducing inflammation and improving overall metabolic function.

METHOD AND MATERIALS

STUDY DESIGN

In this research the researcher employed a longitudinal research design consisted eight weeks, and two groups: an experimental group provided a high-intensity training protocol and a control group keep without training program. Baseline measurements were collect at the start, with follow-up assessments conducted at the end of the eight-week period for the purpose to evaluate changes in alkaline phosphatase (ALP) levels. The details are given in the following diagram.



Population And Sample Selection

The study included a total of 120 participants, with 50% of the participants selected for inclusion in the research. These selected participants, drawn from club-level football players, were further divided into two groups: the control group and the experimental group. Each group comprised 30 participants, ensuring an equal distribution for comparison of the high-intensity training protocol's effects on alkaline phosphatase (ALP) levels.

TRAINING PROTOCOL

The eight-weeks training program schedule, initially stage two-week at 65% intensity, gradually improved to higher intensities over subsequent weeks. Similarly, weeks three-five saw participants engaged in exercises at 70% intensity. In the final position of the program, six-eight, participants engaged at 75% intensity to gains in fitness and

performance. Throughout each training period, participants given 50 seconds of rest between each sets to ensure adequate recovery and optimize training effectiveness.

VARIABLES

This study was consisted two variables independent variable that was High Intensity Training Protocol, and the second one dependent that was Alkaline Phosphatase (ALP).

Variable Name, Measurements and its Unit

S.No	Variable name	Its Measurement	Unit
1	Alkaline Phosphatase (ALP)	Blood-test	IU/L (International Units per Liter)

ETHICAL CONSIDERATIONS

Ethical considerations were more important throughout the study, with all participants well-being and rights. Informed consent was taken from all participants priority basis to their involvement, and ensuring voluntary participation. Additionally, the research protocol reviewed to all participants and approved by the relevant ethics committee to ensure compliance with ethical guidelines and standards.

RESULTS, DISCUSSION

$H_0$1: There is no difference in alkaline phosphatase (ALP) of experimental and control group before the intervention in Male football Students Athletes

Independent sample t-test

	Group	N	Mean	SD	Df	t	Sig. (2-tailed)
Alkaline Phosphatase Pre	Experimental	30	86.766	4.636	58	.112	.911
	Control	30	86.633	4.604	57.997		

A t-test was conducted to compare the levels of alkaline phosphatase in the experimental group and the control group after the eight-week training program. The results indicated that there was no significant difference between the experimental group (M = 86.77, SD = 4.64) and the control group (M = 86.63, SD = 4.60); df (58, 57.997), t= 0.112, p = .911. This suggests that the high-intensity training protocol did not

significantly affect alkaline phosphatase levels when compared to the control group.

H_A2: There is significant difference in alkaline phosphatase (ALP) of experimental and control group after the intervention in Male football Students Athletes.

Independent sample t-test

	Group	N	Mean	SD	df	t	Sig. (2-tailed)
Alkaline Phosphatase Post	Experimental	30	72.800	5.202	58	-10.945	.000
	Control	30	86.700	4.617	57.195		

A t-test was conducted to compare the levels of alkaline phosphatase in the experimental group and the control group after the eight-week training program. The results indicated a significant difference between the experimental group (M = 72.80, SD = 5.20) and the control group (M = 86.70, SD = 4.62); df(58, 57.195), t= -10.95, p < .001. This suggests that the high-intensity training protocol significantly reduced alkaline phosphatase levels in the experimental group compared to the control group.

H_A3: There is significant difference in alkaline phosphatase (ALP) of experimental group before and after the training intervention

Paired Samples Statistics

		Mean	N	SD	T	df	Sig. (2-tailed)
Pair 1	Alkaline Phosphatase Experimental Pre	86.766	30	4.636	11.241	29	.000
	Alkaline Phosphatase Experimental Post	72.800	30	5.202			

A paired-samples t-test was conducted to compare the levels of alkaline phosphatase before and after the eight-week training program in the experimental group. There was a significant decrease in alkaline phosphatase levels from pre-training (M = 86.77, SD = 4.64) to post-training (M = 72.80, SD = 5.20); t(29) = 11.24, p < .001. These results suggest that the high-intensity training protocol significantly reduced alkaline phosphatase levels in the experimental group.

$H_0$4 There is no significant in alkaline phosphatase (ALP) of Control

Group before and after the training intervention

Paired Samples Statistics

			Mean	N	SD	T	df	Sig. (2-tailed)
Pair 1	Alkaline Experimental Pre	Phosphatase	86.633	30	4.604	-.626	29	.536
	Alkaline Experimental Post	Phosphatase	86.700	30	4.617			

A paired-samples t-test was conducted to compare the levels of alkaline phosphatase before and after the eight-week training program in the experimental group. There was no significant difference in alkaline phosphatase levels from pre-training (M = 86.63, SD = 4.60) to post-training (M = 86.70, SD = 4.62); df(29,) = -0.626, p = .536. These results suggest that the high-intensity training protocol did not significantly affect alkaline phosphatase levels in the experimental group.

CONCLUSION

The results of this study indicate that eight-week program of high-intensity training protocol significantly reduces alkaline phosphatase (ALP) levels, in male football student-athletes. The experience of this reduction in ALP levels suggested that high-intensity training protocol positively effects in ALP level. Similarly, the control group didn't experience significant difference in ALP, emphasizing the efficacy of the training intervention. These findings underscore the impact of high-intensity training to enhance ALP, because it significant decrease in ALP levels with in the experimental group highlights the importance of incorporating such training protocols in athletic programs. Future research should increase the long-duration effects and mechanisms underlying these changes to optimize training strategies further.

RECOMMENDATION

Based on the current findings of study, it is recommended that male football student-athletes incorporate high-intensity training protocols into their regular fitness routines to improve ALP. Coaches and athletic trainers should design training programs that progressively increase intensity over an eight-week period to achieve significant biochemical adaptations, as indicated by the reduction in alkaline phosphatase levels observed in this study. Therefore, future research should purpose to

investigate the long-duration effects of high-intensity training on ALP. So, the studies should also explore different intensities and durations of high-intensity training to determine the most effective protocols for optimizing athlete health and performance. By expanding the scope of research, a more comprehensive understanding of the benefits and mechanisms of high-intensity training can be achieved

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