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Effects Of Plyometric Training On C-Reactive Protein (CRP) In Football Players: Preparation From Pre-Season To In-Season

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Abstract

Exercise plays a key role in maintaining physical health by strengthening bones and muscles, regulating metabolism, preventing chronic diseases, and promoting longevity. ***Objective****: The purpose of this study was to examine the effects of a 12-week plyometric training program on C-reactive Protein (CRP) levels in elite male football players from South Punjab, Pakistan, during the pre-season to in-season phase.*

Methods*: A total of 60 male football players aged 18-28 were randomly selected and divided into two equal groups: an experimental group (n = 30), which received the plyometric training, and a control group (n = 30), which did not undergo any specific training. The study utilized a pre-test and post-test experimental design. [1]Blood samples were collected from all participants before and after the intervention to measure CRP levels. The experimental group participated in football-specific plyometric training three times a week for 12 weeks, while the control group followed their routine activities without any training intervention. CRP levels were analyzed using independent t-tests and paired t-tests to assess changes within and between groups.*

Results*: Pre-test results showed no significant difference in CRP levels between the experimental (M = 0.6733) and control groups (M = 0.6733), with a p-value of 1.000. Post-test analysis revealed a significant reduction in CRP levels in the experimental group (M = 0.5867), compared to the control group (M = 0.6767), with a p-value of .005. Additionally, within-group analysis showed a significant decrease in CRP levels in the experimental group from pre-test to post-test (p = .000), whereas no significant change was observed in the control group (p = .745).*

Conclusion*: The findings suggest that a 12-week plyometric training program significantly reduces CRP levels in elite football players, indicating the program's potential to mitigate inflammatory responses during the pre-season to in-season transition. No significant changes were observed in the control group, highlighting the importance of targeted training for improving health markers in athletes.*

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***Keywords**: Plyometric training, C-reactive Protein, football players, inflammatory biomarkers, pre-season, in-season, elite athletes.*

INTRODUCTION: Training has been a fundamental element of an athlete's life. Training involves a systematic and structured approach for improving an athlete's physical,technical, and mental abilities in specific sports. It has beenestablished as top priority in all thoughts and actions, and it is considered as one of the most important aspects. Physical fitness is a key thing to enjoy healthy life and it is important for all individuals, Athletes, and professionals. Fora healthy and active life routine life management is very important(Stark,2022).

C-reactive protein (CRP) is a well-known acute-phase reactant synthesized by the liver in response to inflammation, infection, or tissue injury. It serves as a sensitive marker of systemic inflammation and is widely used in clinical settings to assess the risk of cardiovascular disease, infections, and inflammatory disorders. In the context of athlete health, monitoring CRP levels can provide valuable insights into the inflammatory status and overall well-being of athletes.

Conversely, other research suggests that regular plyometric training may lead to reductions in inflammatory markers over time. These findings may be attributed to the overall improvements in fitness, muscle strength, and metabolic health associated with plyometric exercise, which can have anti-inflammatory effects on the body (Peake et all., 2005). The relationship between plyometric training and inflammatory markers is influenced by various factors, including training intensity, volume, frequency, and individual athlete characteristics. Athletes with well-designed training programs may exhibit more favourable adaptations, while those with higher training volumes or intensity may experience greater fluctuations in inflammatory markers (Smith, 2004). Plyometric training offers significant benefits for athletic performance, but its effects on inflammatory markers are complex and multifaceted. Future research is needed to elucidate the mechanisms underlying these effects and to optimize training protocols for minimizing inflammation while maximizing performance and athlete health.

Objectives of the study

1) To analyse the effects of Plyometric Training on C-reactive Protein, between experimental group and control group Pre-intervention
2) To analyse the effects of Plyometric Training on C-reactive Protein between experimental group and control group post-intervention
3) To determine the effect of the intervention (Plyometric Training) on C-reactive Protein (CRP) levels by comparing pre-test and post-test results of the experimental group and control group.

Hypotheses of the study

1) H0: There is no significant different in C-reactive Protein, between experimental group and control group Pre-intervention
2) HA: There is significant different in C-reactive Protein between experimental group and control group post-intervention
3) HA: The intervention leaded a significant improvement in C-reactive Protein in the experimental group between pre-test and post-test, while the control group show no significant difference.

Literature

Plyometric training, characterized by rapid muscle stretching and contracting movements, has become a cornerstone of athletic conditioning programs aimed at enhancing performance.

However, understanding its impact on inflammatory markers in athletes is crucial for optimizing training protocols and ensuring athlete health.

Inflammatory markers such as C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and plasma viscosity serve as indicators of inflammation and tissue damage in the body. While acute exercise bouts typically lead to transient increases in these markers due to muscle damage and repair processes, regular training can result in adaptations that modulate the inflammatory response (Clarkson & Hubal, 2002: Smith, 2004). Research into the effects of plyometric training on inflammatory markers has yielded mixed findings. Some studies have reported acute increases in CRP levels following plyometric sessions, indicating a temporary inflammatory response to the exercise stimulus. However, these elevations often return to baseline levels within a short period, suggesting a normal physiological response to exercise-induced muscle damage (Clarkson & Hubal, 2002).

C-receptive protein (CRP) is a notable intense stage reactant blended by the liver in light of irritation, disease, or tissue injury. It fills in as a delicate marker of foundational irritation and is broadly utilized in clinical settings to evaluate the gamble of cardiovascular illness, contaminations, and provocative problems. With regards to competitor wellbeing, checking CRP levels can give important bits of knowledge into the fiery status and by and large prosperity of competitors.

Ordinary active work, including extreme activity preparing, can prompt transient expansions in CRP levels because of muscle harm and aggravation actuated by work out. While intense heights in CRP are regularly harmless and intelligent of the body's versatile reaction to work out, perseveringly high CRP levels might show fundamental irritation or overtraining disorder, a condition portrayed by extreme preparation without satisfactory recuperation (Meeusen, Duclos, and Cultivate, 2013). The meaning of CRP in competitor wellbeing lies in its job as a biomarker for checking preparing load, recuperation status, and in general provocative weight. Raised CRP levels have been related with expanded hazard of injury, debilitated execution, and compromised resistant capability in competitors. In this way, keeping up with ideal CRP levels through appropriate preparation the executives, sustenance, and recuperation systems is fundamental for amplifying athletic execution and limiting the gamble of unfavourable wellbeing results (Greenlund, and Nair 2003).

Several factors influence CRP levels in athletes, including training volume, intensity, frequency, duration, and individual training status. While acute bouts of exercise can lead to transient increases in CRP, regular training may result in adaptive responses that lower baseline CRP levels and enhance the body's ability to handle inflammatory stimuli. However, excessive training or inadequate recovery can lead to chronic inflammation and elevated CRP levels, predisposing athletes to increased injury risk and performance decrements (Hackney AC. (2006: Greenlund, & Nair 2003). Research conclusion, that C-reactive protein (CRP) serves as a valuable biomarker for assessing inflammatory status and overall health in athletes. Observing CRP levels can assist with recognizing indications of overtraining, aggravation, or injury, taking into consideration ideal mediation and change of preparing conventions. By improving preparation, the board, sustenance, and recuperation methodologies, competitors can keep up with ideal CRP levels and advance long-haul wellbeing and execution.

Framework of the study

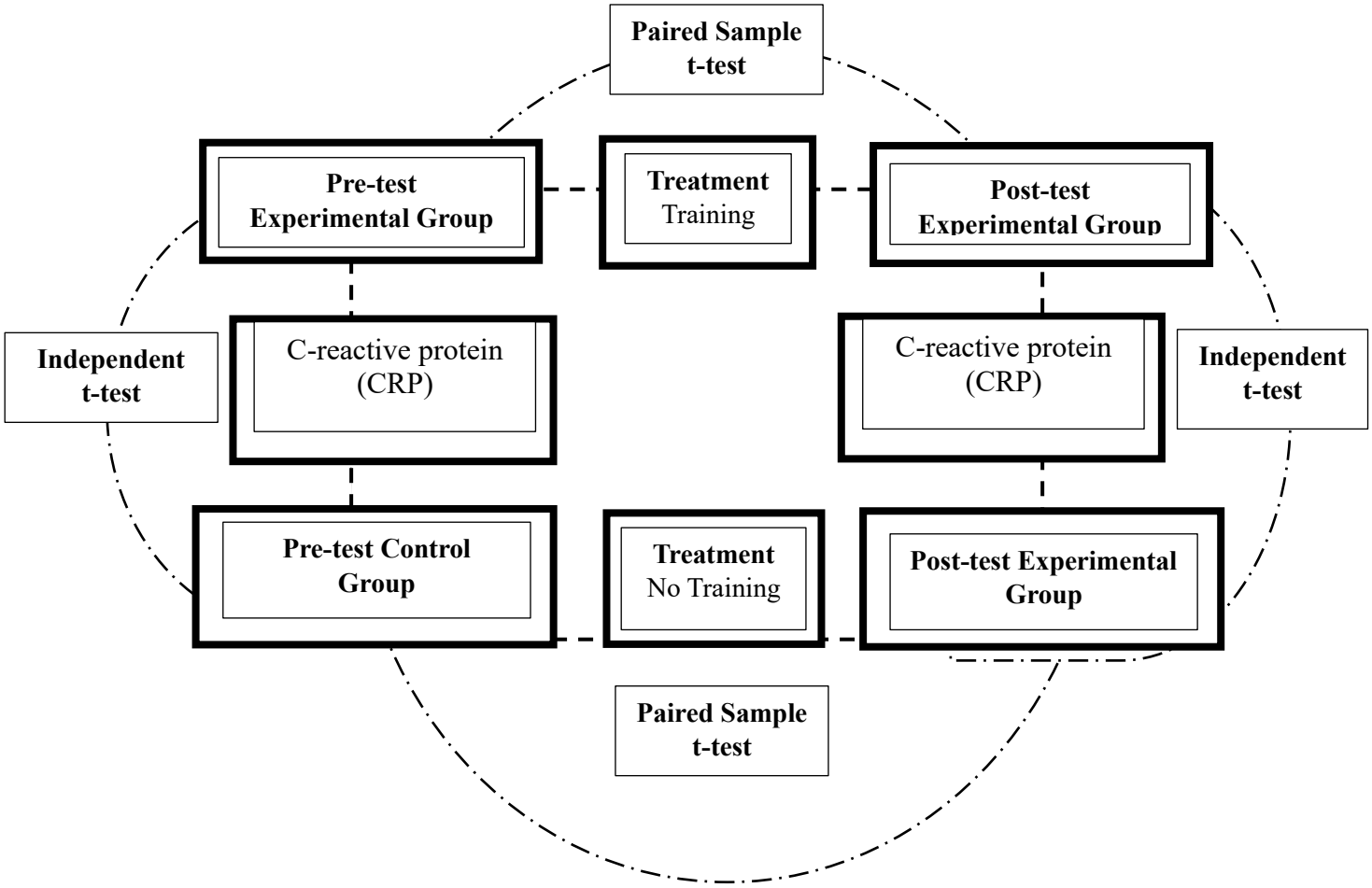

Figure 1: showing Theoretical framework of the Variables

Research Design

Research design is a plan for the solution of a problem (Jones & Lyons, 2004). The pre-test and post-test experimental research design was used to capture the results of the variables in the study.

Population and sampling

In experimental research, participants of the study are the aggregate of all the subjects, objects or members that are directly related to the under-taken problem in connection with collection of the necessary data (Savory et al., 2012). A simple random sampling technique was used to choose the participants from elite level football players from the region of south Punjab, Pakistan.

Inclusion Criteria

i. Off- seasoned football players were included this study.
ii. Football Players had age limit 18-28years.
iii. Only male football players were included.
iv. Athletes who wereagreed to attend the training for twelve weeks

Exclusion Criteria

i. Other sports players were not included in this study.
ii. Players with chronic injuries were not selected.
iii. Female football players were not included.
iv. Rehabilitated players were not included.
v. The football players who were not willing to give blood sample
vi. Football Players who were not agreed to attend the training for twelve weeks.

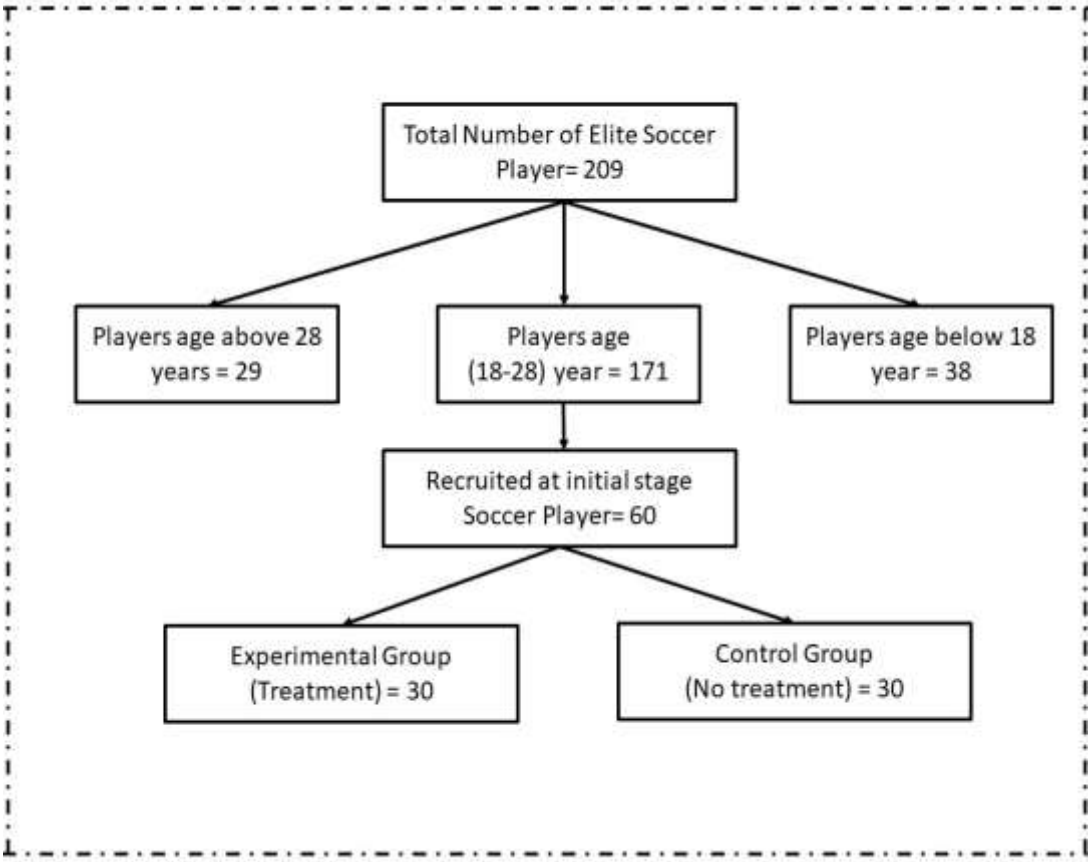

Figure 1: Showing the Selection of the sample

Research Instrument

This study was under taken to determine the Effects of Plyometric Training on C-reactive protein (CRP) of Football PlayersAs the nature of study is experimental, therefore, the researcher collected 5ml of the blood before and after the completion of 12 weeks training program. The collected blood samples wereinspected from the laboratory test for further inspection ofoxidative stress after and before the plyometric training.

Protocol of Training

In this research, the researcher selected the participants on random basis and divided equally into two groups. The experimental group and the control group were comprised of 30

participants respectively. 12-week football specific plyometric training was provided to the experimental group. While the control group kept without training program.

Data Collection Procedure

Beside the tactical, technical and physical training, the football specific plyometric training was given to experimental group for 12 weeks on three alternate days (Monday, Wednesday, and Friday) per week. The control group was neither give any sort of training, nor were they allowed to take part in any sort of football specific plyometric training except their routine life activities. After 12 weeks' plyometric training to the experimental group, post-lab-test of each subject of both groups was performed to measure the dependent variables. The post-test score of each subject of both groups was recorded with the reference to all the dependent variables.

Results

H0: There is no significant different in C-reactive Protein, between experimental group and control group Pre-intervention

Table1 (a): Descriptive Statistics

	Group	N	Mean	Std. Deviation
C-Reactive Protein	Experimental Group	30	.6733	.12847
	Control Group	30	.6733	.13374

The experimental group and the control group had the same mean values (M = 0.6733, SD = 0.12847 for the experimental group and M = 0.6733, SD = 0.13374 for the control group) in the pre-test assessments of C-reactive Protein (CRP).

Table 1 (b): Inferential Statistics

(Levene's Test for Equality of Variances)				**Independent Samples Test**	
		F	**Sig.**	**t-value**	**Sig-(2-tailed)**
C-Reactive Protein	Equal variances assumed	.069	.793	.000	1.000
	Equal variances not assumed			.000	1.000

The p value of Levene's test is greater than 0.05 which means that variance of the population from which sample drawn is equal. The comparison's t-value was 0.000, and its significance value was 1.000 which is greater than 0.05, meaning that there was no significant difference between the two groups' pre-test results. This indicates that before the start of the intervention, the C-Reactive Protein baseline values for the two groups were similar.

HA: There is significant different in C-reactive Protein between experimental group and control group post-intervention

Table 2 (a): Descriptive Statistics

	Group	**N**	**Mean**	**Std. Deviation**
C-Reactive Protein	Experimental Group	30	.5867	.12521
	Control Group	30	.6767	.11043

The experimental group and the control group had the same mean values (M = 0.5867, SD = 0.12521 for the experimental group and M = 0.6767, SD = 0.11043 for the control group) in the post-test assessments of C-reactive protein (CRP).

Table 2 (b): Inferential Statistics

(Levene's Test for Equality of Variances)				Independent Samples Test	
		F	Sig.	t-value	Sig-(2-tailed)
C-Reactive Protein	Equal variances assumed	.595	.444	-2.953	.005
	Equal variances not assumed			-2.953	.005

The p value of Levene's test is greater than 0.05 which means that variance of the population from which sample drawn is equal. The comparison's t-value was -2.953, and its significance value was .005 which is less than 0.01, meaning that there was a significant difference between the two groups' post-test results. This indicates that after the intervention, the C-Reactive Protein values significantly differentiate between experimental and control group.

HA: The intervention leaded a significant improvement in C-reactive Protein in the experimental group between pre-test and post-test, while the control group show no significant difference.

Table 3: Inferential Statistics (Paired Samples Statistics)

		Mean	N	Std. Deviation	t-value	Sig-value
Pair 1	C-reactive Protein Exp-Pre	.6733	30	.12847	5.794	.000
	C-reactive Protein Exp-Post	.5867	30	.12521		
Pair 2	C-reactive Protein Control-Pre	.6733	30	.13374	-.328	.745
	C-reactive Protein Control-Post	.6767	30	.11043		

A significant decrease in C-reactive protein levels was shown by the experimental group in the paired samples analysis, with a t-value of 5.794 and a significance level of 0.000, from pre-test (M = 0.6733, SD = 0.12847) to post-test (M = 0.5867, SD = 0.12521). This suggests that the experimental group's C-reactive protein levels were statistically significantly lower as a result of the intervention. As proven by a t-worth of - 0.328 and an importance level of .745, the benchmark group, interestingly, displayed no huge change in C-responsive Protein levels from pre-test (M = 0.6733, SD = 0.13374) to post-test (M = 0.6767, SD = 0.11043). This suggests that neither time nor standard exercises fundamentally impacted the benchmark group's degrees of C-responsive protein.

Discussion

The current study demonstrated that Soccer Specific Training (SST) significantly reduced C-Reactive Protein (CRP) levels in elite soccer players aged 18-28. The findings align with previous research indicating that targeted physical training can reduce systemic inflammation, as reflected by lower CRP levels. A few examinations have investigated the effect of activity on CRP levels, with reliable proof supporting the calming impacts of customary, moderate-to-extreme active work.

For example, Backes et al. (2004) found that work out prompted decreases in CRP were related with diminished cardiovascular gamble in competitors. Additionally, Lavie et al. (2011) announced that stop and go aerobic exercise (HIIT) prompted huge decreases in CRP among youthful grown-ups. In another review, Kasapis& Thompson (2005) saw that aerobic exercise was successful in bringing down CRP levels among sprinters. Williams et al. (2024) gave proof that actual work, paying little heed to power, added to bring down CRP levels, especially in more youthful populaces. This is upheld by Krüger et al. (2016), who found that standard cooperation in sports decreased CRP levels in tip top competitors. Further, Calle et al. (2010) exhibited that obstruction preparing decreased irritation markers, including CRP, in proficient competitors. Beavers et al. (2010) and Beavers et al. (2018) found comparative results in various athletic populaces, recommending that both vigorous and anaerobic preparation modalities are compelling in decreasing CRP levels. Petersen et al. (2005) featured the job of customized preparing programs in overseeing fiery reactions in competitors, a viewing as reverberated by Petersen et al. (2005), who stressed the significance of fitting activity power to individual requirements for ideal calming benefits. All the more as of late, Zwetsloot et al. (2014) and Mc Gettigan et al. (2023) have supported the meaning of organized practice regimens in diminishing CRP levels in youthful competitors. Fortunato et al. (2018) exhibited that sports-explicit preparation fundamentally brought down CRP and other fiery markers among soccer players, giving further approval to the adequacy of SST as seen in the ongoing review. Palmer et al. (2015) likewise found that preparing particularity assumes a pivotal part in balancing irritation in tip top competitors, supporting the idea that designated practice conventions are fundamental for ideal wellbeing results.

These discoveries on the whole recommend that Soccer Explicit Preparation improves execution as well as offers critical medical advantages by lessening foundational aggravation. The ongoing review adds to this developing assemblage of proof, affirming that SST is a viable mediation for bringing down CRP levels in world class soccer players.

Findings of the Study

Findings of pre-test experimental group and control group.

The analysis revealed no significant difference in C-reactive Protein levels between the experimental group (n = 30, received Soccer Specific Training) and the control group (n = 30, without training) among elite soccer players aged 18-28. The two gatherings had indistinguishable mean C-receptive Protein levels (M = 0.6733), with a p-worth of 1.000, showing that the Soccer Explicit Preparation didn't essentially further develop C-responsive Protein levels contrasted with the benchmark group.

Findings of posttest experimental group and control group

The analysis revealed a significant difference in C-Reactive Protein levels between the experimental group (n = 30, received Soccer Specific Training) and the control group (n = 30, without training) among elite soccer players aged 18-28. The mean C-Responsive Protein level was lower in the exploratory gathering (M = 0.58) contrasted with the benchmark group (M = 0.67), with a p-worth of .005, showing that the Soccer Explicit Preparation was successful in diminishing C-Receptive Protein levels.

Findings of pre and post insights of exploratory and control bunch

The examination uncovered a huge decrease in C-receptive Protein levels in the exploratory gathering (n = 30) following Soccer Explicit Preparation, with the pre-test mean diminishing from 0.6733 to 0.5867 and a p-worth of .000, demonstrating a massive impact of the preparation. Interestingly, the benchmark group (n = 30) showed no massive change in C-responsive Protein levels, with the pre-test mean at 0.6733 and the post-test mean at 0.6767 (p-

esteem = .745), recommending that the shortfall of preparing didn't affect C-receptive Protein levels.

5.3 Conclusion

The current review analysed the impacts of Soccer Explicit Preparation on C-Responsive Protein (CRP) in tip top soccer players matured 18-28. The examination uncovered that while there were no tremendous contrasts between the trial and control bunches preceding the preparation mediation, significant changes were noticed post-intercession in the exploratory gathering, featuring the beneficial outcomes of Soccer Explicit Preparation on a few wellbeing related biomarkers.

To start with, the discoveries showed no tremendous contrasts in CRP level between the trial and control bunches before the preparation mediation. The mean qualities for these biomarkers were equivalent between the two gatherings, with p-values surpassing .05, demonstrating no gauge distinctions. In any case, following the mediation, huge enhancements were kept in the exploratory gathering, recommending that Soccer Explicit Preparation extensively affected the chose biomarkers.

As far as CRP, the examination showed that while no massive change happened in the benchmark group, the trial bunch displayed a critical decrease in CRP levels post-preparing, with a p-worth of .005, exhibiting the preparation's viability in lessening irritation.

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