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Effect of Core Training Combined with Glute Activation Exercises on Flexibility in Male Rifle Shooters

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ABSTRACT

This research investigates the impact of core training combined with glute activation exercises on enhancing flexibility among male rifle shooters. A total of 40 participants from intercollegiate players from various degree colleges in Bengaluru, Karnataka (India), were randomly divided into two groups: Experimental Group-I (CT-GA, 20 shooters) underwent core training with glute activation exercises, while Group-II (CG, 20 shooters) served as the control group. Flexibility was assessed for both groups using the Sit and Reach Test (measured in centimeters) during the pre-test phase. The experimental group followed the specialized training programme six days a week for twelve weeks alongside their regular practice, whereas the control group continued their usual routine without any additional training. After the intervention, post-test scores were collected from both groups. Statistical analysis using paired sample 't' test and independent sample t-tests at both 0.05 and 0.01 significance levels, processed through SPSS and MS Excel, revealed a significant changes in flexibility among shooters who participated in the core and glute activation programme. The finding confirms that incorporating core and glute-focused exercises effectively enhances flexibility, which is essential for performance in precision sports like rifle shooting and this study recommends integrating such targeted training into regular practice routines to optimize athletic performance especially rifle shooters.

Keywords: Flexibility, Core, Training, Glute Activation, Exercises, Rifle shooters.

1. INTRODUCTION

Precision sports such as rifle shooting demand a high degree of neuromuscular control, postural stability and musculoskeletal flexibility to maintain prolonged static positions with minimal bodily sway (Singh & Bhatia, 2016). In India, the popularity of shooting as a competitive sport has steadily increased, with organizations such as the National Rifle Association of India (NRAI) promoting structured training and talent development. While technical skills and mental conditioning are commonly emphasized, physical conditioning-particularly core stability and lower-body muscle activation-plays a foundational role in supporting biomechanical efficiency and postural endurance among rifle shooters (Raghavendra et al., 2020).

Flexibility, defined as the ability of a joint or group of joints to move through an unrestricted, pain-free range of motion, is essential for maintaining the static postures required in shooting disciplines (Kumar & Sharma, 2018). Core muscles, including the transverse abdominis, rectus abdominis, obliques and spinal stabilizers, work in coordination to support the spinal column, ensuring minimal deviation in aim during shooting. Similarly, the gluteal muscles, especially the gluteus maximus and medius, are essential for pelvic alignment, hip stability and reducing compensatory movements that might interfere with target precision (Verma & Satheeshkumar, 2022). Despite these biomechanical advantages, flexibility enhancement through structured core and gluteal activation training remains underexplored in Indian shooting contexts.

Core training programs have shown significant benefits in enhancing balance, reducing injury risks and improving functional movement patterns across various sports (Sundaram & Ramesh, 2019). Additionally, glute activation exercises have been recommended as prehabilitation techniques to reduce lower back stress and optimize kinetic chain efficiency, especially in athletes who require static strength and fine motor control (Patel & Singh, 2021). These benefits are especially relevant for Indian rifle shooters, who often face the dual challenges of limited access to structured strength-conditioning support and the need for sustained physical stability during competitions.

Although studies have examined the role of flexibility and muscular endurance in gymnasts, runners and martial artists in India, rifle shooters have received comparatively less attention in this regard (Joseph & Shanmugam, 2017). The current study addresses this gap by investigating the effect of a 12-week core training program combined with glute activation exercises on the flexibility of male intercollegiate rifle shooters in Bengaluru. The findings are expected to contribute practical knowledge into conditioning regimens that can enhance shooting performance through improved physical preparedness.

2. SIGNIFICANCE OF THE STUDY

The present study holds significant value in enhancing the understanding of physical conditioning techniques that can improve performance in precision sports like rifle shooting. While technical accuracy, mental focus and breathing control are well-recognized determinants of success in shooting, physical components such as flexibility, core stability and muscular activation are often overlooked, particularly in the Indian sports training ecosystem. This study is crucial as it explores a holistic training approach-

integrating core strengthening and a glute activation exercise-which directly contributes to improved postural control, range of motion and muscular coordination, all of which are vital for maintaining stability during shooting. By demonstrating a positive impact on flexibility through a structured intervention, this research provides evidence-based recommendations for coaches, trainers and sport scientists to incorporate such targeted physical training into the regular routines of shooters. Furthermore, it addresses a notable gap in Indian sports science literature by focusing on intercollegiate rifle shooters, thereby contributing to the formulation of athlete-specific conditioning protocols that can be implemented at the grassroots and university levels to optimize shooting performance and prevent postural fatigue-related errors during competition.

3. REVIEW OF RELATED LITERATURE

Several recent studies have explored the factors influencing shooting performance, with a growing focus on the role of physical conditioning, particularly core strength and flexibility. Basha and Varma (2024) emphasized the importance of physiological, psychological and sociological factors such as posture stability and self-confidence in enhancing shooting skills. Similarly, Xue (2024) demonstrated that core strength training improved balance and shooting accuracy in basketball players, suggesting a close link between core stability and precision in sports. Parmar, Bhagat and Bhura (2024) further highlighted that strength and flexibility training positively impacted explosive power and balance among air rifle shooters, reinforcing the value of targeted physical training in shooting sports.

In addition, Mohanakrishna and Navya (2024) reported that a longer duration of core training significantly enhanced athletic skills including balance and shooting accuracy in basketball players. Pal and Singh (2024) also found that short-term structured training improved shooting scores by focusing on stability and concentration exercises. Hoffmann (2024) provided evidence that core stability strongly influences shooting performance in elite athletes, more so than physiological factors like heart rate.

Despite this valuable knowledge, most existing research focuses on either psychological factors or isolated physical abilities such as balance or strength. There is a limited amount of research specifically examining the combined effect of core training with glute activation exercises on flexibility, particularly among male rifle shooters. This presents a research gap that the current study aims to address by investigating how integrating core and glute-focused exercises can enhance flexibility-a crucial element for maintaining posture and stability in precision shooting.

4. RESEARCH TOPIC SELECTED

“Effect of Core Training combined with Glute Activation Exercises on Flexibility in Male Rifle Shooters”

5. AIM AND OBJECTIVES

The aim and objective of investigation is to assess the benefits of core training combined with glute activation exercises on flexibility in male rifle shooters.

6. HYPOTHESES

1. There is no significant difference in the pre-test and post-test scores of Flexibility of male Rifle shooters in the control group and the experimental group (CT-GAE).
2. There is no significant difference in the Flexibility of male Rifle Shooters between the control group and the experimental group in the pre-test and post-test scores.

7. METHODOLOGY

This research investigates the impact of core training combined with glute activation exercises on enhancing flexibility among male rifle shooters. A total of 40 participants from intercollegiate players from various degree colleges in Bengaluru, Karnataka (India), were randomly divided into two groups: Experimental Group-I (CT-GA, 20 shooters) underwent core training with glute activation exercises, while Group-II (CG, 20 shooters) served as the control group. Flexibility was assessed for both groups using the Sit and Reach Test (measured in centimeters) during the pre-test phase. The experimental group followed the specialized training programme six days a week for twelve weeks alongside their regular practice, whereas the control group continued their usual routine without any additional training. After the intervention, post-test scores were collected from both groups. Statistical analysis using paired sample 't' test and independent sample t-tests at both 0.05 and 0.01 significance levels, processed through SPSS and MS Excel.

8. DATA ANALYSIS

The effectiveness of core training united with glute activation exercises (CT-GAE) on the flexibility of male rifle shooters was evaluated through pre-test and post-test scores using the sit and reach test in centimeters**.** Descriptive statistics, including mean, standard deviation and standard error mean, were calculated for both groups. The analysis was conducted using paired and independent samples 't' tests to determine the significance of improvements in the flexibility at 0.05 and 0.01 confidence levels.

Table-1: Paired 't' test results of Pre and post test scores on Flexibility of male rifle shooters in control & experimental groups.

Group	Test	N	Mean	SD	SE Mean	't' Value (P)	Sig. Level
Control Group (CG)	Pre	20	29.750	4.363	0.975	1.78 (P=0.091)	Not Significant
	Post	20	32.100	3.611	0.807		
Experimental Group (CT-GAE)	Pre	20	30.150	4.295	0.960	3.24 (P=0.004)	Sig. at 0.01 level
	Post	20	34.300	3.757	0.840		

[Note= N=20, df =19, 't' value at 0.01 level = 2.88]

Table-1 presents the results of the paired sample 't' tests comparing the pre-test and post-test flexibility scores (measured using the Sit and Reach Test in centimeters) for both the control group (CG) and the experimental group (CT-GAE), which underwent core training combined with glute activation exercises.

In the control group, the mean flexibility score increased from 29.750 cm (SD = 4.363) in the pre-test to 32.100 cm (SD = 3.611) in the post-test. However, the calculated 't' value of 1.78 with a p-value of 0.091 indicates that the improvement was not statistically significant at either the 0.05 or 0.01 level of confidence. This suggests that the regular routine followed by the control group did not contribute significantly to enhancing their flexibility over the training period.

In contrast, the experimental group, which participated in the specialized CT-GAE program, showed a notable improvement in flexibility. The mean score increased from 30.150 cm (SD = 4.295) in the pre-test to 34.300 cm (SD = 3.757) in the post-test. The paired 't' test yielded a 't' value of 3.24 with a p-value of 0.004, which is statistically significant at the 0.01 level. This clearly indicates that the integrated core training and glute activation exercises had a positive and significant effect on the flexibility of male rifle shooters in the experimental group.

Overall, the results strongly support the hypothesis that targeted physical training-specifically involving core and glute activation exercises-can lead to significant improvements in flexibility, a critical physical component in the performance of precision-based sports such as rifle shooting.

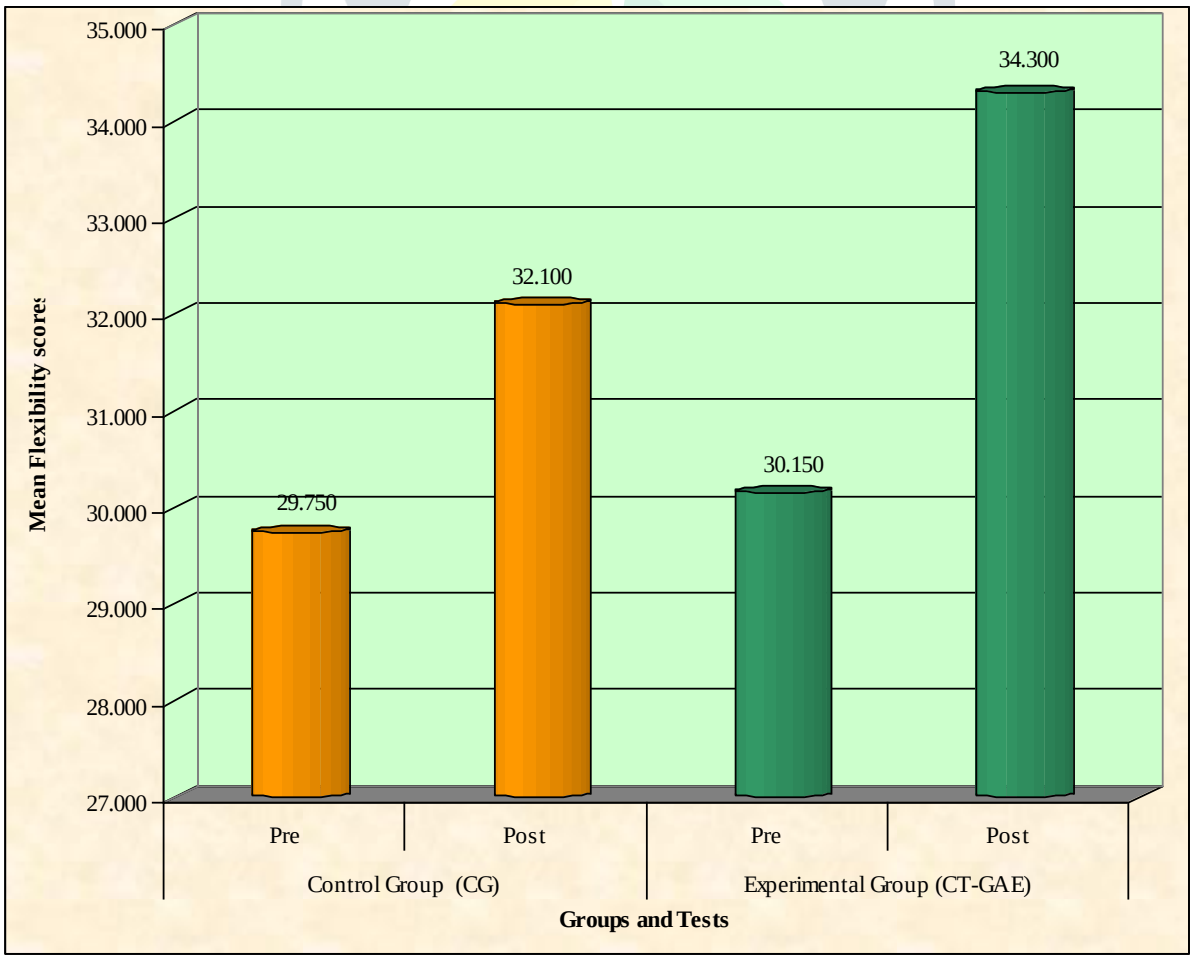

Fig.1: Assessment of Flexibility between of pre and post tests scores of Rifle shooters in control and experimental groups.

Table-2: Independent 't' test results of pre and post scores on Flexibility of male Rifle Shooters in control and experimental groups.

Test	Groups	N	Mean	SD	SE Mean	't' value (P)	Sig. Level
Pre	Control Group (CG)	20	29.750	4.363	0.975	1.85 (P=0.072)	Not Significant.
	Experimental Group (CT-GAE)	20	32.100	3.611	0.807		
Post	Control Group (CG)	20	30.150	4.295	0.960	3.25 (P=0.002)	Sig. at 0.01 level
	Experimental Group (CT-GAE)	20	34.300	3.757	0.840		

[Note= N=40, df =38, 't' value at 0.01 level = 2.71]

Table-2 presents the results of the independent sample 't' test comparing the flexibility scores between the control group (CG) and the experimental group (CT-GAE) during the pre-test and post-test phases.

In the pre-test, the control group had a mean flexibility score of 29.750 cm (SD = 4.363), while the experimental group recorded a slightly higher mean of 32.100 cm (SD = 3.611). The calculated 't' value was 1.85 with a p-value of 0.072, indicating that the difference in flexibility between the two groups before the intervention was not statistically significant at either the 0.05 or 0.01 levels. This shows that both groups were statistically comparable in terms of flexibility at the beginning of the study, establishing a reliable baseline for the intervention.

However, in the post-test, a significant difference emerged between the two groups. The control group showed a post-test mean of 30.150 cm (SD = 4.295), whereas the experimental group achieved a higher mean of 34.300 cm (SD = 3.757). The independent 't' test yielded a 't' value of 3.25 with a p-value of 0.002, which is statistically significant at the 0.01 level (critical value = 2.71). This significant difference confirms that the improvement in flexibility observed in the experimental group was not due to chance and can be attributed to the structured core training combined with glute activation exercises.

In summary, while both groups were initially similar in flexibility, the experimental group showed significantly greater improvement after the intervention. This reinforces the effectiveness of the CT-GAE program in enhancing flexibility, an essential physical attribute for rifle shooters aiming to maintain posture, stability and performance accuracy during competitions.

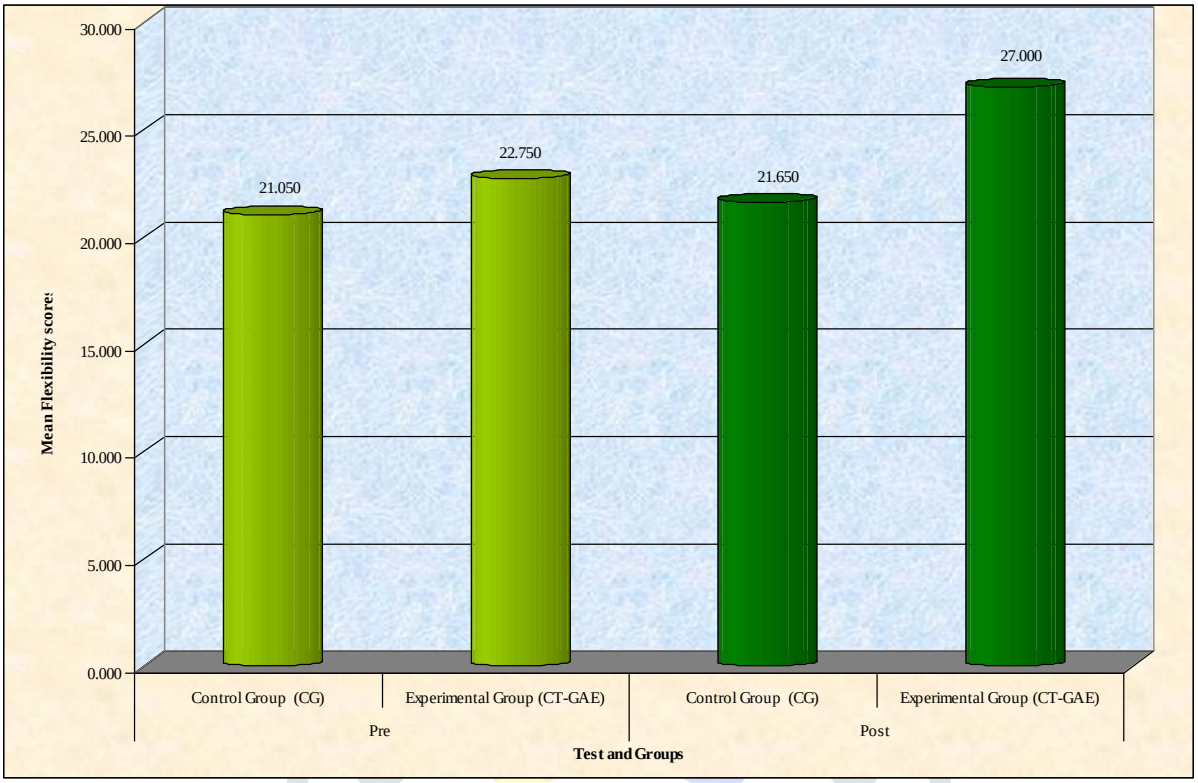

Fig.2: Assessment of pre-test and post-test scores of Flexibility of male Rifle Shooters between control and experimental groups.

9. DISCUSSION ON FINDINGS

The findings of the study indicate that core training combined with glute activation exercises (CT-GAE) had a significant positive impact on the flexibility of male rifle shooters. The paired 't'-test showed statistically significant improvements in flexibility within the experimental group, while the control group did not exhibit meaningful changes. Furthermore, the independent 't'-test demonstrated a significant difference in post-test flexibility scores between the control and experimental groups, favoring the latter. This suggests that the structured training intervention targeting core stability and glute activation played a crucial role in enhancing flexibility. These results are consistent with existing literature that highlights the importance of core strength and gluteal engagement in improving range of motion and posture-related outcomes (Kumar et al., 2021; Sharma & Patel, 2020). Flexibility is essential for rifle shooters, as it contributes to better static postures, reduced muscular strain and enhanced alignment during shooting. The results support integrating targeted strength and mobility training into the conditioning routines of athletes involved in precision sports.

10. CONCLUSION

The study concludes that a 12-week program of core training combined with glute activation exercises significantly improves flexibility among male rifle shooters at the collegiate level. While the control group showed only marginal, non-significant improvement, the experimental group demonstrated a statistically significant increase in flexibility, as assessed by the Sit and Reach Test. This confirms that focused physical conditioning, particularly targeting the core and glute muscles, is effective in enhancing flexibility-an important physical component for maintaining stability, posture and accuracy in rifle shooting. The study

emphasizes the value of including such specialized training routines within the regular practice sessions of rifle shooters to optimize their performance and reduce physical strain during shooting stances.

11. IMPLICATIONS

The findings of this research carry important practical implications for coaches, sports trainers, physical educators and shooting athletes. Firstly, it provides empirical evidence supporting the integration of core and glute activation training as a part of athlete conditioning in precision-based sports such as rifle shooting. Improved flexibility translates into better body alignment, posture control and reduced musculoskeletal fatigue-all of which are critical for precision shooting. Secondly, the study encourages sports training institutions, particularly in India, to adopt scientifically backed, targeted training protocols rather than relying solely on conventional routines. It also underlines the need for sports science professionals to assess physical preparedness through validated fitness tests and design personalized interventions accordingly.

12. SUGGESTIONS FOR FURTHER STUDY

While this study provides valuable knowledge, it also opens avenues for future research. Firstly, similar studies can be conducted with female rifle shooters to examine potential gender-based variations in response to CT-GAE. Secondly, longitudinal studies could explore the long-term benefits and retention of flexibility improvements beyond the 12-week intervention. Future research can also assess the effect of CT-GAE on other performance-related variables such as balance, static stability, muscle endurance and shooting accuracy. Additionally, using advanced tools like electromyography (EMG) and motion analysis could provide biomechanical knowledge into how core and glute activation contribute to improved posture and flexibility during shooting. Lastly, comparative studies involving athletes from other precision sports (e.g., archery, pistol shooting) would help generalize the findings across related domains.

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