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Comparative Effects of Traditional Resistance Training and Circuit-Based Resistance Training on Flexibility Among Intercollegiate Male Handball Players

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Abstract: This study examined the comparative effects of traditional resistance training and circuit-based resistance training on flexibility among 36 intercollegiate male handball players aged 18–23 years. Using a randomized pre-test and post-test design, participants were divided into three groups: traditional resistance training, circuit-based resistance training, and control. Both training interventions produced significant improvements in flexibility, while the control group showed negligible change. Circuit-based resistance training demonstrated greater gains compared to traditional resistance training, highlighting its dynamic and multi-muscle engagement benefits. The findings suggest that structured resistance programs, particularly circuit-based formats, can effectively enhance flexibility, reduce injury risk, and improve athletic performance in handball. Coaches and trainers may incorporate these methods into conditioning regimens to optimize player outcomes.

Keywords: Comparative Effects, Traditional Training, Traditional Resistance Training, Circuit-Based Resistance Training, Flexibility, Male Handball Players

INTRODUCTION

Resistance training has been studied thoroughly for its contributions to strength and endurance, and what also needs to be researched is its effects on flexibility-an important aspect of athletic performance (Fatouros *et al.*, 2006). Flexibility is essential in athletes but most important in high-intensity sports like handball, where the player needs to showcase agility, strength, and a wide range of motion in very quick dynamic movements (Gruić *et al.*, 2011). The study entitled "Comparative Effects of Traditional and Circuit-Based Resistance Training on Flexibility Among Intercollegiate Male Handball Players" set out to explain the relative merits of different resistance training modes among intercollegiate male handball athletes regarding flexibility and hence the purpose behind identifying the training mode most suited to increasing flexibility.

Flexibility is a very important contributor toward functional capacity in the athlete, allowing for better efficiency of movements, increased reach, and less tension in muscles during activity (Ingraham 2003). To be the best in terms of performance and prevention of injuries, one needs very good flexibility since handball is dynamic in direction changes, jumping, and quick sprinting (Asker & Møller, 2018). Less flexibility translates to less than optimal performance as an athlete as well as greater chances for muscular injury. Hence, there is an imperative need for specific programs relevant to demands of the sport (Coelho, 2007). Resistance training has an established plethora of advantages, including increasing strength, improving endurance, and ensuring joint stability; however, whether resistance training effects have an impact in the flexibility domain remains controversial. This research separates these two forms of resistance training: Traditional Resistance Training (RTG) (Tiggemann *et al.*, 2016) and Circuit-Based Resistance Training (CBRTG) (Ramos-Campo *et al.*, 2021), to determine which of them bears more advantage to flexibility outcomes. Normal resistance training, however, focuses on isolated movements specific to muscle groups, which require decent rest, while circuit training brings together a platform of exercises with less rest engaging multiple muscle groups for aerobic and muscular benefits.

This study uses a randomized pre-test and post-test group design for 36 male intercollegiate handball players, aged 18 to 23 years. Participants were assigned to three groups, these being traditional resistance training group (RTG), circuit-based resistance training group (CBRTG), and control group (CG). An intervention lasting four weeks had both experimental groups attend supported training sessions focusing on progressive load, recovery, and flexibility-oriented exercises. Otherwise,

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such exercises were excluded for the control group. This means that group serves as a baseline for assessing the intervention effects. Initial assessment establishes flexibility scores to subjects, thereby allowing it to compare flexible scores following evaluation. Flexibility is expected to increase under both methods of resistance training but to a different extent.

The statistical methods used to compare the changes across groups would be t-test and ANOVA to analyse the flexibility changes. The outcome of this research will yield results to be valuable to trainers and sports scientists in the designing exercise regimen for handball athletes. This would determine the more effective modality of improving flexibility and optimizing the training protocols to reduce injuries and enhance performance in handball and similar high-intensity sports. It aims to broaden the understanding of resistance training in flexibility development, placing it between the theory of research and application in practice in sports science.

This is an excellent approach of trying to go beyond training procedures, but it may also adopt an extensive exploration of the realm through which strength relates to flexibility and might thus open avenues for new possibilities for further development of athletes' performance. In fact, they may lead to regimens that could be organized to meet completely individualized training needs, that is, for the demands that each athlete is facing in order to provide optimum performance with minimal risk of injury. Development of personalized plans allows coaches to further enhance the specific needs of athletes while maximizing their physical capabilities and helping to improve long-term success in sport.

METHODS

Subjects Selections

36 male intercollegiate handball players were recruited for the study and ranged from 18 to 23 years in age. All the subjects underwent complete physical examinations before the commencement of the study to ascertain that they had no injuries or illness that would impede participation in the training program. Each subject was fully aware of the exercise procedures involved in the study via oral and written communication protocols. Participants were also required to complete medical history forms, a questionnaire on training background, as well as sign the written informed consent form before venturing into the study. Subjects were gone under 4 weeks training sessions Focuses on flexibility, strength, endurance, and gradual load progression with recovery.

Experimental Design

- A pre-test and post-test randomized group design followed the experiment. Participants were assigned randomly to one of the three groups:
- **Experimental Group I (RTG - Resistance Training Group)**: 12 subjects underwent a program of traditional resistance exercises geared toward different muscles.
- **Experimental Group II (CBRTG - Circuit Based Resistance Training Group)**: The 12 subjects participated in a circuit-based resistance training program that comprised exercises directed towards the major muscle groups and performed in a circuit form.
- **Control Group (CG)**: 12 subjects assigned to act as a control group were not participating in a specific resistance training program.

RESULTS

The most comprehensive description of effects in traditional resistance training (RTG) and circuit-based resistance training (CBRTG) with control condition (CG) concerned flexibility patterns among intercollegiate male handball players. Flexibility assessment results were achieved by scores of pre-tests and post-test, and the significant changes were confirmed through statistical analysis across groups.

Table 1: Flexibility Outcomes for Resistance Training Group (RTG)

Groups	Mean	N	MD	SD	SD E	t' Ratio
Pre-Test	21.08	12	3.08	2.57	0.36	8.61
Post -Test	24.17	12		1.75		

**Significant at 0.05 levels*

Table 1 points out the Resistance Training Group (RTG). The pre-test mean score for flexibility was 21.08, which remarkably increased to 24.17 after the training intervention. The mean difference (MD) of 3.08 devotes itself to improvement in flexibility. The standard deviation (SD) of 2.57 indicates the variability of pre-test scores, and the t-value of 8.61 confirms that the improvement was statistically significant.

Table 2: Flexibility Outcomes for Circuit Training Group (CBRTG)

Groups	Mean	N	MD	SD	SD E	t' Ratio
Pre-Test	20.75	12	4.25	1.97	0.52	8.23
Post -Test	25	12		2.11		

**Significant at 0.05 levels*

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Descriptive statistics for the Circuit Training Group (CBRTG) are presented in table 2. The means pretest of 20.75 increased to 25.00 with mean difference (MD) of 4.25 which suggest better advancement in flexibility than RTG. Standard deviation (SD) of 1.97 indicates a slightly lower variability of scores on the pre-test as compared to RTG. The t-value of 8.23 also indicates a statistically significant improvement in flexibility following the training.

Table 3: Flexibility Outcomes for Control Group (CG)

Groups	Mean	N	MD	SD	SD E	t' Ratio
Pre-Test	21.08	12	0.58	2.51	0.33	-1.76
Post -Test	21.67	12		2.06		

**Significant at 0.05 levels*

The Control Group (CG) has not engaged itself in any form of specific training intervention, and table 3 results revealed minimal development in flexibility. The pre-test means of 21.08 has only increased a little to 21.67, accounting for a mean difference (MD) of 0.58. The t-value that goes with that change, which is -1.76, indicates that the change is not statistically significant. This group serves as comparison control for the effect of training interventions.

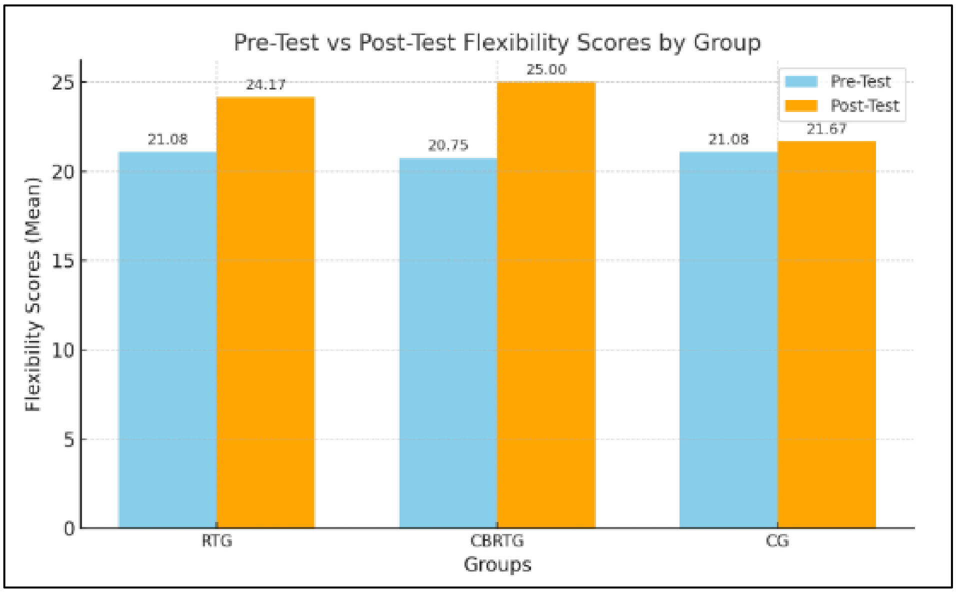

Figure 1: Pre-test and post-test flexibility scores on RTG, CBRTG, and CG

Figure 1 is a bar graph illustrating the pre-test and post-test flexibility scores for the three groups (RTG, CBRTG, and CG). The graph provides a clear comparison of the changes in flexibility before and after the training interventions.

Table 4: ANOVA Results on Comparing Flexibility Across Training Groups

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F	p-value (Sig.)
Between Groups	389.88	2	194.94	30.94	0
Within Groups	203.33	33	6.16		

Table 4 shows the results of ANOVA for the general comparison of flexibility improvement across the three groups (RTG, CBRTG, and CG). The Sum of Squares (SS) for Between Groups (389.88) reflects the variation coming from RTG, CBRTG, and CG. The SS of Within Groups is 203.33. Thus, Mean Square (MS) values result from dividing SS by the respective degrees of freedom (df). The F-value (30.94) says that variance is much greater between the groups than within them. The p-value (0.0000) indicates that the difference is significant and further states that training interventions (RTG and CBRTG) produce a very significant change of flexibility in comparison with the Control Group.

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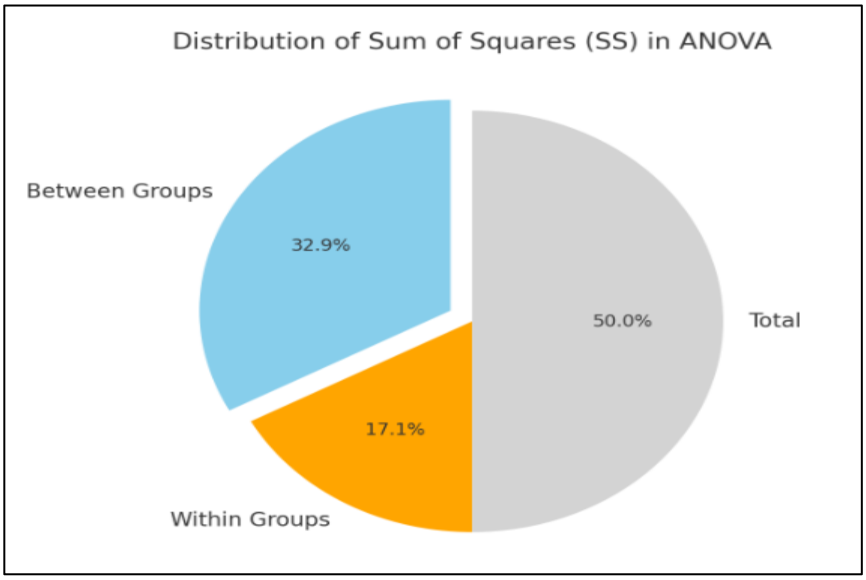

Figure 2: Distribution of the Sum of Squares (SS) in the ANOVA analysis

Figure 2, showing the distribution of the Sum of Squares (SS) in the ANOVA analysis. The "Between Groups" section is highlighted to emphasize its significance in the analysis. The colors align with the pre-test and post-test visualization for consistency.

DISCUSSION

The goal of the present study was to determine the effect of two modalities of circuit resistance training, namely Resistance Training (RTG) and Circuit Based Resistance Training (CBRTG), on flexibility in male intercollegiate handball players. Flexibility improved significantly for both experimental groups-i.e., RTG and CBRTG-as compared to negligible changes noted in the control group (CG).

The data from the Resistance Training Group (RTG) had proved a significant change in flexibility (Leite *et al.*, 2017), from a pre-test mean of 21.08 to a post-test value of 24.17. This change, being 3.08 in its mean difference, was statistically proven significant (t=8.61). The factor or reason of flexibility enhancement occurred mainly because resistance training is generally repetitively carried out and very controlled gives full range muscle movement with joint mobility. The findings coincide with the previous study regarding the contribution of resistance training in flexibility development when properly executed. Circuit Training Group (CBRTG), of the three groups, had the highest improvement (Seo *et al.*, 2019). The average pre-test means of 20.75 increased from there to post-test mean scores of 25.00, registering a mean difference of 4.25 and a t = 8.23. Further, Circuit training uses many forms of dynamic exercises and stretches that are most significant to improving flexibility; on top of that, the cardiovascular and muscle conditioning may also attribute to these better results. This indicates that circuit training is appropriate for sport, such as handball, which requires a combination of flexibility, endurance, and overall fitness.

Meanwhile, as far as flexibility improvement is concerned, Control Group (CG) only makes a negligible gain (Marques & González-Badillo, 2006), since the pre-test mean was 21.08, which slightly increased to 21.67. Mean difference is equal to 0.58, at the same time the t-value was recorded to be -1.76, which showed that this was an insignificant improvement statistically. Such improvements can only be achieved through a systematic and targeted approach to a particular physical attribute, in this case flexibility.

A comparative analysis using ANOVA strongly confirmed the efficacy of the experimental training modalities. The F-statistic of 30.94 and a highly significant p-value (0.0000) indicated considerable differences found among the three groups in flexibility improvement. The high between-group sum of squares (SS = 389.88) demonstrated that the training interventions were responsible for most variability in flexibility outcomes and that random factors could not be attributed. Thus, these results further validate resistance and circuit training to be superi-er effective than no training intervention (Buch *et al.*, 2017). Besides, the implications of these findings suggest that organized training may lead to outstanding improvements in performance, to the end of benefiting people at all levels of fitness and for every possible athletic goal (Marques & González-Badillo, 2006). Both resistance and circuit training yielded effective results in the improvement of flexibility, though circuit training gave slightly higher benefits (Simão *et al.*, 2011). These should therefore be included as part of their conditioning programs to further encourage people to give the best performance while minimizing injuries in the event they do so (Talpey & Siesmaa, 2017). Circuit training provides the ultimate advantage of improving overall fitness along with flexibility, which makes it even more beneficial for sports such as handball. Incorporating circuit training

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into normal practice sessions will give the athletes the great benefit of improved performance and adaptability in almost any competitive environment.

CONCLUSION

The present Studies shows how structured training programs can influence the flexibility of young male handball players competing in intercollegiate matches. Resistance training helped improve this flexibility, with remarkable post-test scores compared to Pre-Test scores. Though, among all training modalities, circuit training proved to be the best, with pronounced improvement found in most changes in flexibility. Possible reasons include the dynamic nature of the exercises involved in circuit training, making it quite a suitable component in conditioning programs for athletes. Improvements in flexibility for the Control Group, which did not undergo any form of training, were practically same or at the minimal level, which can point to the need for targeted interventions. Again, from the ANOVA results, the difference across groups has also confirmed the statistical significance as regards the effectiveness of resistance and circuit training modalities. Finding implies the integration of these modalities by coaches and trainers in their programs for flexibility enhancement, injury risk prevention, and athletic performance improvement. The outcome looks promising; however, further studies should be done to investigate the longitudinal effects of these training modalities and validate results across bigger and more diverse samples. In a nutshell, the study reiterates the important role of structured training in optimizing flexibilities and athletic outcomes.

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