EXPLORING THE RELATIONSHIP BETWEEN CLOSE KINEMATIC CHAIN EXERCISE FOR CORE MUSCLES AND SHOULDER DYSFUNCTION IN YOUNG MALE AND FEMALE BADMINTON PLAYERS

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Abstract
This paper discusses whether there exists an impact of Closed Kinetic Chain (CKC) exercises on the shoulders and core strength in young male and female badminton players. Five hundred sixty individuals aged between 16 to 25 years, comprising 30 males and 30 females, underwent an intervention program at both pre-test and post-test. Shoulder dysfunction was measured using the Shoulder Pain and Disability Index (SPADI) and their core strength through CKC exercises. Scores for shoulder dysfunction decreased significantly, from 45.3 ± 12.4 to 30.1 ± 10.2 ($p < 0.001$), whereas mean core strength scores improved significantly, increasing from 10.2 ± 1.5 to 14.3 ± 1.7 ($p < 0.001$). Strengthening of the core was also significantly linked with lower scores in SPADI, $r = -0.68$, $p < 0.01$: shoulder dysfunction dramatically decreased with increased core strength. Such findings will demonstrate how well CKC exercises improve core stability and further reduce shoulder pain and impairment, thus meaning that this training regimen should focus on strengthening the core to maximize performance and avoid problems related to the shoulder for athletes.

Keywords: *Close Kinematic, Chain Exercise, Core Muscles, Shoulder Dysfunction, Young Male, Female, Badminton Players*

1. INTRODUCTION

The field of research is important, especially for athletes who play dynamic sports such as badminton, in which activity and musculoskeletal health are interrelated. The musculoskeletal system is highly stressed, more so on shoulders and the core, because the heavy demands of agility, coordination, and strength in badminton apply pressure on the shoulders and core. Pain, limited range of motion, and diminished function can be regarded as prominent symptoms of shoulder dysfunction among badminton players. If this dysfunction is left unchecked, it can impair sports performance significantly and may even contribute to chronic diseases. Therefore, an appreciation of the factors that cause shoulder dysfunction in the badminton players becomes crucial when designing the effective rehabilitation and training programs.

CKC exercises are part of the now immense pool of training programs that focus on the improvement of performance and rehabilitation. CKC exercises work across several joints and muscle groups at the same time, as the distal segment (hands or feet) needs to be 'locked' in place. This is because a core or a solid core provides the necessary stability, generates power and executes definite motions. Thus, for badminton players, CKC exercises specifically developed to exercise one's core muscles are particularly vital. Research suggests that athletes with a strong core exhibit improved athletic performance and decrease the likelihood of developing some injuries such as dysfunction in the shoulders. Through examination of how successfully CKC exercises improve core strength and then how that affects badminton players' shoulder function, thus very important knowledge will be gained by coaches, trainers, and sports rehabilitation specialists. In the next study, we would like to observe the relation between the shoulder dysfunction in young male and female badminton players and CKC workouts for the core muscles. In that respect, this investigation is aimed at filling up the knowledge gap concerning the ways targeted exercise interventions can effectively help shoulder complaints as well as athletic performance by concentrating on this group. For the sake of getting a deeper insight into what will make our training programs better suit the specific needs of men and women, this research will try to ascertain whether any gender difference exists in the way each gender responds to CKC exercises.

1.1 Background on Badminton and Physical Demands

It is a high-paced game characterized by rapid movement, swift direction change, and explosive moves that put high levels of physical pressure on its players. Because of these demands, various regions of the body, particularly the shoulder and core muscles, are severely strained. Shoulder dysfunction is more common in athletes through repetitive strain injuries and deficiency of stable core muscles through explosive overhead shots and quick footwork. The presented combination underlines the importance of an emphasis on core strength and shoulder health as part of the training programs in badminton to optimize performance and prevent injury.

1.2 Significance of Shoulder Dysfunction

In badminton players, shoulder dysfunction represents one of the frequent complaints and often presents with pain, limited mobility, and poor performance. This disease impairs athletic ability, making it painful to demand the best

from athletes. It is also associated with the risk of chronic injuries, which could jeopardize the professional future of an athlete. Understanding the basic sources of shoulder dysfunction is, therefore crucial in developing effective preventive and treatment strategies. Coaches and sports experts can help athletes achieve the best shoulder health and subsequently improve overall performance in the sport by dealing with them proactively.

2.REVIEW OF LITREATURE

Bauer, Gruber, and Muehlbauer (2022) This relationship has been looked into by researchers who researched on sub-elite male adolescent handball players. The study indicates great relations between core muscle strength endurance and performance in actions involving the upper-extremity; this implies that having a developed core might have an effect on the athlete's ability to execute strength and coordination-related actions in the upper limbs better. Such a study would suggest the inclusion of training the core muscles in the training regime for athletes since it might potentially affect their direct performance metrics.

In a related vein, Bazrafshan (2023) This dissertation focuses on conducting a scoping review about preventing upper extremity injury programs for adolescent throwing athletes. By laying out such an importance, process-oriented tests of physical competence can be regarded as critical to injury prevention. Bazrafshan emphasizes the fact that targeted injury prevention strategies, if they are made aware of the complete comprehension of the athlete's potential physical capabilities, then lead to more effective training interventions. This study applies very much to sports like badminton, wherein the upper extremities of most players are at risk of injury and because of this, it can be used as a blueprint for developing preventive measures that are specifically suited for young athletic populations.

Moreover, BISRAT (2021) This paper examines the effect of core strength training on the shooting accuracy and a range of other physical fitness components in U-15 male handball players. Findings reported that core strength training positively influences both shooting accuracy and other physical fitness parameters as well. It confirms that having a strong core is crucial for various athletic performances, and hence, their training programs should be primarily focused on core workouts. BISRAT's work feeds into and further supports the growing body of evidence that core strength is an essential pre-requisite for optimizing performance and reducing injury risk in sports that commonly require dynamic upper-body movement.

Gasibat et al. (2023) The paper undertook a systematic study on specific gender-based imbalances in muscle patterns of elite badminton players. Based on the findings, such a study by the researchers indicated pronounced differences in muscle imbalances between males and females as the reasons for performance and injury susceptibility. This means an understanding of gender-based patterns would be very critical in ensuring that training programs tailor attacks to handle some muscular weaknesses. Such targeted interventions might improve performance in general and decrease the risk of injury, especially around the theme of shoulder dysfunction, which is well-documented in badminton players.

3. RESEARCH METHDOLOGY

3.1 RESEARCH DESIGN

The current study was a quantitative investigation of the shoulder function and physical performance of young badminton players. This type of approach facilitates easier collection of numerical data, hence enabling the carrying out of statistical analysis to identify any relations between variables.

3.2 SAMPLE SELECTION

In all, 60 young badminton players were recruited for the study - thirty males and thirty females. The sample used was a purposive one to ensure that participants would at least possess some form of badminton expertise. Participants' age was set in between 16 to 25 years. This age range was targeted for participants who were at a developmental stage where shoulder function and physical performance are critical for success in sports.

3.3 ASSESSMENTS

A battery of tests was administered to participants in order to assess their shoulder function and physical performance:

3.3.1 Physical Performance Assessment:

A battery of CKC-based activities was used to measure core strength. Exercises that are frequently used in assessments include wall sits and single-leg squats, which measure the core's strength and stability. Every task related to the evaluation was overseen. Measurements were taken as needed before and after the intervention.

Metrics Of Performance: The performance metrics, which included the quantity of repetitions finished and the amount of time spent on the task, offered quantifiable data for evaluating the measurements.

3.3.2 Shoulder Function Evaluation:

Shoulder Pain and Disability Index (SPADI) was the tool administered to the subjects in an attempt to evaluate their shoulder dysfunction. It is a standardized questionnaire measuring the level of pain and disability associated with shoulder problems. It has two subscales divided into two categories, graded from 0 to 10, one for pain and the other for impairment.

The function of the shoulder was evaluated with the help of the SPADI questionnaire, completed by the participants

at the baseline before the intervention and at follow-up after the intervention.

3.3.3 Demographic Questionnaire:

Participants' age, gender, training background, and other pertinent information were gathered by the administration of a demographic questionnaire. This data enabled subgroup analysis and gave the study context.

3.4 DATA COLLECTION PROCEDURE

Two stages were included in the data collection process:

3.4.1 Pre-Test Assessment:

Before the intervention, assessments of shoulder function and physical performance were performed on participants. Baseline assessments for shoulder function and core strength were recorded.

In addition, the participants completed the demographic questionnaire to fill out their respective profiles.

3.4.2 Intervention:

The participants in the pre-test tests had to undergo a structured training course, which included improvement in shoulder function and building core strength. There were some CKC exercises aimed at improving the overall performance added to this exercise course.

3.4.3 Post-Test Assessment:

The tests that had been applied in the pre-test stage of the study were repeated after the training program is over with the subjects. With the post-test tests, it was possible to view how the intervention affected changes in shoulder function and core strength.

3.5 DATA ANALYSIS

Utilising statistical tools like SPSS or R, data were examined to guarantee precision and dependability in statistical calculations:

3.5.1 Descriptive Statistics:

To compile the data, descriptive statistics were generated. This includes core strength and SPADI score metrics like means, standard deviations, and ranges.

3.5.2 Correlation Analysis:

Pearson's correlation coefficient was used to evaluate the relationship of shoulder function to core strength. The test also indicated whether a direction or strength of linear relationship between the variables was present. A p-value less than 0.05 was considered statistically significant for determining the significance of the correlation.

4. DATA ANALYSIS AND RESULTS

4.1 Demographic Information

An overview of the participants' demographic details can be seen in Table 1.

Table 1: Demographic Characteristics of Participants

Demographic Factor	Male (n=30)	Female (n=30)	Total (n=60)
Age (Mean ± SD)	20.5 ± 2.3	19.8 ± 1.9	20.2 ± 2.1
Training Experience (Years)	5.3 ± 1.5	4.7 ± 1.2	5.0 ± 1.4
Injury History (Yes/No)	8/22	10/20	18/42

Summarized demographics of the study participants are shown in Table 1; these included 30 male badminton players and 30 female badminton players. The mean age of the sample was 20.2 years (SD = 2.1 years), with males averaging 20.5 years of age (SD = 2.3 years) and females averaging 1 year less, at 19.8 years (SD = 1.9 years). This means that most of the players are in the late teens to early twenties age groups, which is consistent with the average age range of players competing in badminton. The male participants reported an average 5.3 years (SD = 1.5) of training experience whereas females reported an average of 4.7 years (SD = 1.2). This resulted in a total mean of 5.0 years (SD = 1.4) for training experience. This means that male players may possess a minimal trainings' experience relative to females players, a factor that may influence their physical and psychical well-being. There were 18 (30%) cases with the history of injury; of which 8 (about 26.7%) and 10 (approximately 33.3%) are males and females, respectively. This means that most respondents had past injuries, and therefore focused therapies should be conducted to avail relief from shoulder dysfunction in badminton players to enhance performance.

4.2 Physical Assessment Outcomes

The outcomes of the physical evaluations performed both before and after the intervention are compiled in Table 2.

Table 2: Physical Assessment Outcomes

Assessment Type	Pre-Intervention (Mean ± SD)	Post-Intervention (Mean ± SD)	p-value
Core Strength (CKC Exercise)	10.2 ± 1.5	14.3 ± 1.7	<0.001
SPADI Score (Shoulder Dysfunction)	45.3 ± 12.4	30.1 ± 10.2	<0.001

Table 2. Summation of results of physical assessments before and after treatment. CKC, close kinetic chain; SPADI, Shoulder Pain and Disability Index. Note that the table below illustrates CKC exercises that were used to assess core strength and SPADI used in measuring shoulder dysfunction. The averages of these can be included in the table as well. Participants' mean scores on their core strength were 10.2 (SD = 1.5) before intervention, which improved significantly to post-intervention 14.3 (SD = 1.7) with a p-value < 0.001 shows that improvements are significant. It proves that CKC workouts duly enhanced participants' core strength. Conversely, the mean SPADI score, which measures the level of impairment of shoulder function, was significantly decreased from 45.3 (SD = 12.4) before the intervention to 30.1 (SD = 10.2) after it, with a p-value less than 0.001. This reduction therefore indicates an improvement in the significant shoulder function after the intervention as well as a general reduction in dysfunction. Overall, statistics from Table 2 confirm how much CKC exercise routine is effective for both strengthening core muscles and alleviating shoulder discomfort in young badminton players.

4.3 Correlation Analysis

Table 3: Analysis of the Relationship Between Shoulder Dysfunction Scores and Improvements in Core Strength

Variable	Mean Change (Pre to Post)	Standard Deviation	Correlation Coefficient (r)	p-value
Core Strength Improvement (CKC)	4.1 ± 1.2	1.5	-0.68	<0.01
Shoulder Dysfunction (SPADI Score)	-15.2 ± 2.9	3.0		

The improvement in shoulder dysfunction scores as rated using SPADI and that in core strength, as rated through CKC exercises, has been illustrated with the correlation analysis presented in Table 3. It was found that shoulder dysfunction scores as well as the improvement in core strength were negatively correlated, with a p-value of less than 0.01 and r = -0.68. This large negative correlation indicates shoulder dysfunction scores plummeted dramatically as participants' core strength increased, suggesting levels of shoulder pain and disability declined.

Postintervention, the results showed that the participants' core stability and strength improved remarkably, with the mean change in core strength from the pre-test to the post-test showing an increase of 4.1 ± 1.2, and a standard deviation was 1.5. Conversely, the average change in shoulder dysfunction was -15.2 ± 2.9 with a standard deviation at 3.0 based on the SPADI score. Proof that the training in CKC was effective can be seen on the shoulder function through the mean change in SPADI scores, which is indeed negative, indicating that significant reduction in shoulder impairment and pain was achieved.

The association is confirmed by the statistical significance of the p-value below 0.01, providing strong evidence that, among young badminton players in the sample, increases in core strength are associated with a decrease in shoulder dysfunction. Such a study implies that core fitness is an important attribute for diminishing shoulder-related difficulties and, in general, may prevent injury to a certain extent. Therefore, the present study highly applies to athletic training and rehabilitation settings.

5. CONCLUSION

The relationship of shoulder dysfunction among young male and female badminton players and the core muscular strength developed through Closed Kinetic Chain (CKC) exercises were considered in the study. Results: Significant, high scores for shoulder dysfunction ratings (45.3 ± 12.4 to 30.1 ± 10.2, p < 0.001) and strong core strength improvements were shown by the individuals (mean increase from 10.2 ± 1.5 to 14.3 ± 1.7, p < 0.001). Significant correlations between core strength gains and decreases in shoulder pain and impairment were established (r = -0.68,

$p < 0.01$). Such correlations draw attention to the relevance of core stability training for sports in which shoulder function is important for performance and in prevention of injury, like badminton. It further goes to reveal that incorporating CKC exercises into training plans can improve the level of physical performance and relieve shoulder pain. Therefore, for the trainers, coaches, and rehabilitation experts who are looking for a means of improving the general physical capabilities of their athletes as well as their low rate of injury, this is the ideal strategy.

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