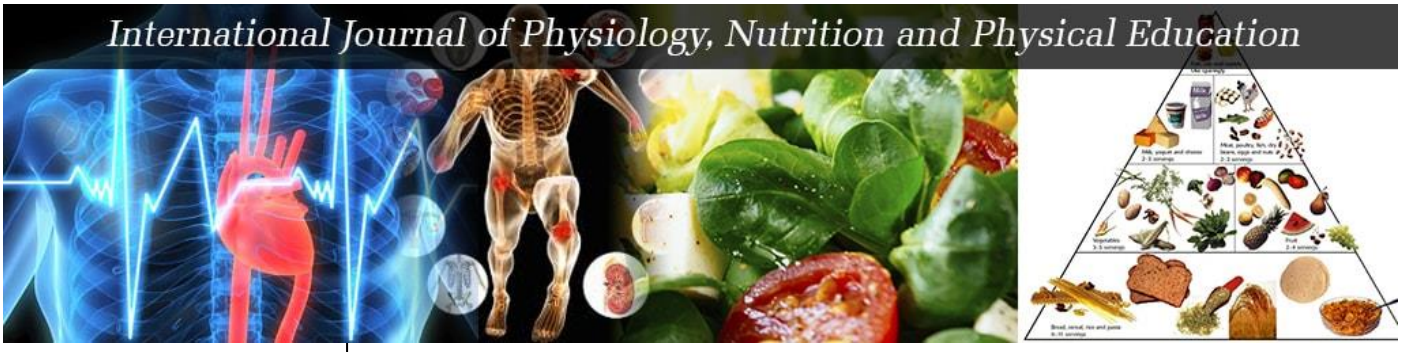

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Core endurance and its correlation with shoulder dysfunction in recreational cricket players: A pilot study

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Abstract
Background: The kinetic chain theory proposes a functional relationship between the core and extremities, and suggests that optimal shoulder function requires contributions from the lower extremities and core. However, there is lack of robust body of evidence to support core instability and shoulder injuries hypothesis. This study was carried out to find whether lack of core endurance correlate with shoulder dysfunction.
Methodology: Twenty male recreational cricket players with mean age of 21.25±2.09 years, playing at collegiate level were recruited in the study. Kerlan-Jobe Orthopaedic Clinic Shoulder and Elbow Score (KJOC) Questionnaire had been used to assess shoulder dysfunction. Assessment of core endurance was carried out by using McGill's torso muscular endurance test battery.
Results & Conclusion: Correlation between shoulder dysfunction and trunk flexor endurance with the p value of 0.977 (>0.05), trunk extensor endurance with the p value of 0.183 (>0.05), trunk right side flexor endurance with the p value of 0.505 (>0.05), trunk right side flexor endurance with the p value of 0.680 (>0.05).This study observes no statistical significant correlation between core endurance scores and shoulder dysfunction among recreational cricket players.

Keywords: Core stability, KJOC, McGill core endurance, shoulder dysfunction

1. Introduction
Core muscles consists of the diaphragm at the upper section, abdominals and obliques at the front and lateral section, paraspinals and gluteals at the back and pelvic floor and hip junction at the lower section.[1] When we consider overhead athletes, above definition has been expanded to include the bony skeleton, ligaments, and musculature of the shoulder girdle.[2] Core acts at the center of the kinetic chain, is an essential component that helps to maximize athletic function [3]. Upper limb and lower limb muscles must work coherently with the core muscles to execute controlled and coordinated movements. Core stability allows the athletes to maximize force production while minimizing loads placed on peripheral joints [4]. Core instability maximizes the loads on peripheral joints which results in excessive accessory gliding thereby increasing risk for dysfunction, injury and pain.
Researchers found that core endurance tests are the most reliable measurements for core stability, followed by the flexibility, strength, neuromuscular control, and functional tests, respectively [5]. McGill core endurance test battery which includes flexor endurance, extensor endurance, right side flexor endurance and left side flexor endurance was adopted in this study. Cricket, a popular sport played in many countries, is enjoyed by players of all levels of ability, recreation to competitive sports [6]. Although cricket is a non-contact sport, there is a wide variety of causes of injuries. Injuries on the cricket field tend to fall into one of two categories: repetitive or overuse and impact. Shoulder injuries (21.7%) occurred mostly during throwing and bowling [7]. Male adolescent recreational cricket players reported a high prevalence of cricket-related musculoskeletal pain and dysfunction [8]. Reduced kinetic stresses on the shoulder may prevent injury, leading to greater durability and health of the throwing shoulder [9]. Kerlan-Jobe Orthopaedic Clinic Shoulder and Elbow Score (KJOC) Questionnaire is more sensitive than other tools in detection of upper extremity dysfunction in overhead-throwing athletes.

The kinetic chain theory proposes a functional relationship between the core and extremities, and suggests that optimal shoulder function requires contributions from the lower extremities and core [10]. However, there is lack of robust body of scientific evidence to support core instability and shoulder injuries hypothesis [11] and to our knowledge no previous studies have investigated the relationship between core stability and shoulder dysfunction among recreational cricket players.

The research question is; 'is correlation exist between lack of core endurance and shoulder dysfunction in recreational cricket players?'

2. Methodology

2.1 Study design and Participants

Twenty, male recreational cricket players with age 18-25 years, playing at collegiate level in college in Dakshina Kannada at A J Institute of Medical Sciences, were recruited for this correlation study. Purposive sampling was adopted. The study was approved by the Ethical Committee of A J Institute of Medical Sciences, Mangalore. An informed consent was obtained from all participants in our study.

2.2 Procedure

Recreational cricket players who get pain during and after playing game and those not taking any performance enhancing drugs and not under specific core endurance training other than their routine exercise were recruited for the study. Subjects having current episodes of back pain, discomfort in contracting abdominal muscles, current acute injuries in kinetic chain (ankle, knee, hip, back and shoulder) were excluded. After receiving consent from participants, Kerlan-Jobe Orthopaedic Clinic Shoulder and Elbow Score (KJOC) Questionnaire had been given to fill up. Help from the investigator was required to make participants understand about the questionnaire. KJOC comprises 10 individual questions, scored via VAS that is 10cm long. The results of 10 questions were summed, and the total score is reported from 0-100 (100=high level of physical capability or best score). This questionnaire has been found to be sensitive to athletes in overhead sports with intraclass correlation coefficient of 0.88. [12] Subjects had been classified as having shoulder dysfunction if they had history of noncontact shoulder injury and scored less than 80 on KJOC.

Assessment of core endurance was carried out by using McGill's torso muscular endurance test battery. Test battery consists of trunk flexor endurance test, trunk extensor endurance test and trunk lateral endurance test. Trunk flexor endurance was assessed by patient seated with hip and knee bend to 90 degrees and leaning on a board positioned at a 60 degrees incline (Figure 1). Participants were asked to maintain this position throughout the test after the board is removed. Trunk extensor endurance was assessed by Biering-SØrensen test where stabilization was provided by therapist (Figure 2). Trunk lateral endurance (both, right and left) was assessed in a full side bridge position, keeping both legs extended and the sides of the feet on the floor (Figure 3 and 4). Duration of hold in these positions was recorded using stopwatch. Test was terminated when there was a noticeable change in trunk position. Adequate rest between the procedures had given to avoid fatigue related bias in scores.

Fig 1: Trunk flexor endurance test

Fig 2: Trunk extensor endurance test

Fig 3: Trunk lateral trunk endurance test (Right)

Fig 4: Trunk lateral trunk endurance test (Left)

2.3 Outcome Measure
Kerlan-Jobe Orthopaedic Clinic Shoulder and Elbow Score for shoulder Dysfunction and McGill's torso muscular endurance test battery individual score for core Endurance assessment.

2.4 Data analysis
The collected information about shoulder dysfunction and core endurance was summarized by using mean and standard deviation. Shapiro-Wilk test was used to test the normality. To find the relationship between core endurance and shoulder dysfunction Spearman correlation test was used. Statistical package SPSS ver.16.0 was used to do the analysis and p value <0.05 was considered as statistically significant.

3. Results
Mean and standard deviation of KJOC score (70.55±6.74), flexor endurance (26.2±14.88), extensor endurance (54.00±29.21), side flexor endurance of right side (51.75±28.49) and side flexor endurance of left side (57.55±28.32). Correlation between shoulder dysfunction and trunk flexor endurance with the p value of 0.977 (>0.05), trunk extensor endurance with the p value of 0.183 (>0.05), trunk right side flexor endurance with the p value of 0.505 (>0.05), trunk right side flexor endurance with the p value of 0.680 (>0.05), indicating no statistical significant correlation. Data points are not clustered along a trend line rather they look like a shotgun blast with R^2 for flexor endurance 0.003(<0.8), extensor endurance 0.143(<0.8), right side flexor endurance 0.006 (<0.8) and left side flexor endurance 0.026 (<0.8), representing no correlation between the variables.

Table 1: Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	20	18.00	26.00	21.2500	2.09950
BMI	20	16.14	30.11	21.9745	4.50437
KJOC Score	20	57.00	79.00	70.5500	6.74712
Flexor Endurance	20	9.00	56.00	26.2000	14.88058
Extensor Endurance	20	20.00	136.00	54.0000	29.21968
Side Flexor Endurance R	20	17.00	135.00	51.7500	28.49354
Side Flexor Endurance L	20	24.00	106.00	57.5500	28.32978
Valid N (listwise)	20				

Table 2: Correlation between the variables

Spearman's rho correlation	Correlation Coefficient	p value
KJOC score and Flexor endurance	.007	0.977
KJOC score and Extensor endurance	.310	0.183
KJOC score and Side flexor endurance R	.158	0.505
KJOC score and Side flexor endurance L	.098	0.680

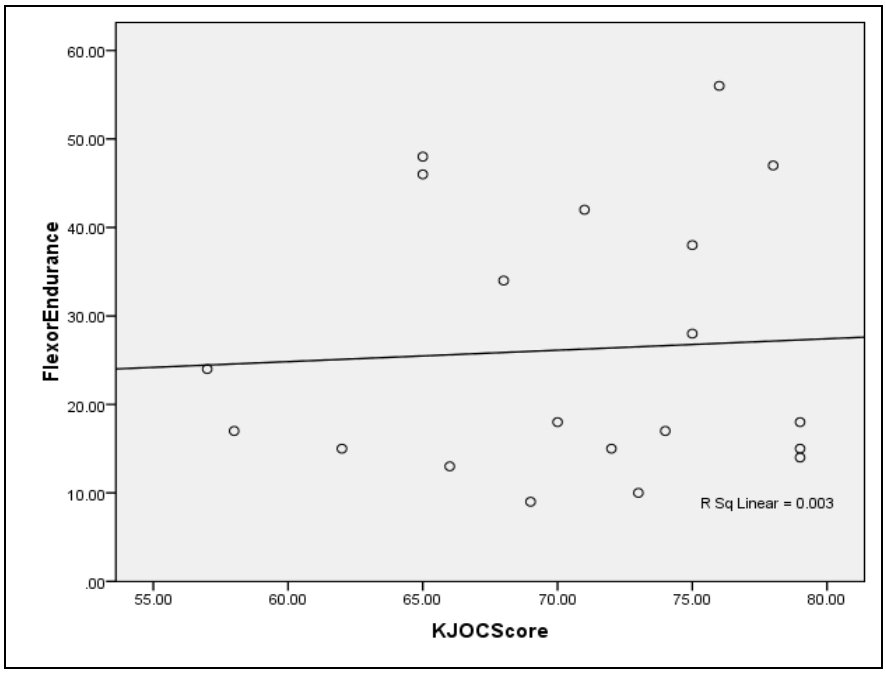

Fig 5: Scatterplot of KJOC score and flexor endurance

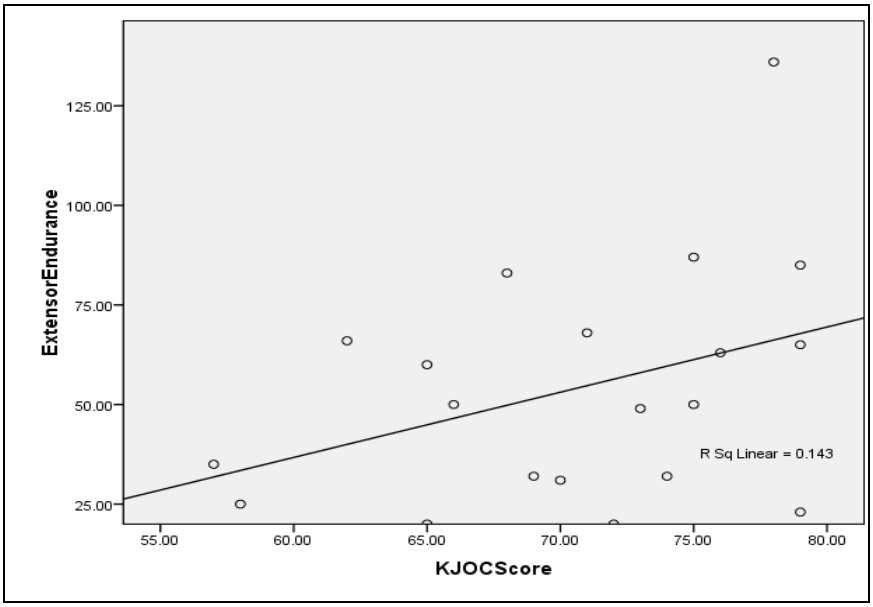

Fig 6: Scatterplot of KJOC score and extensor endurance

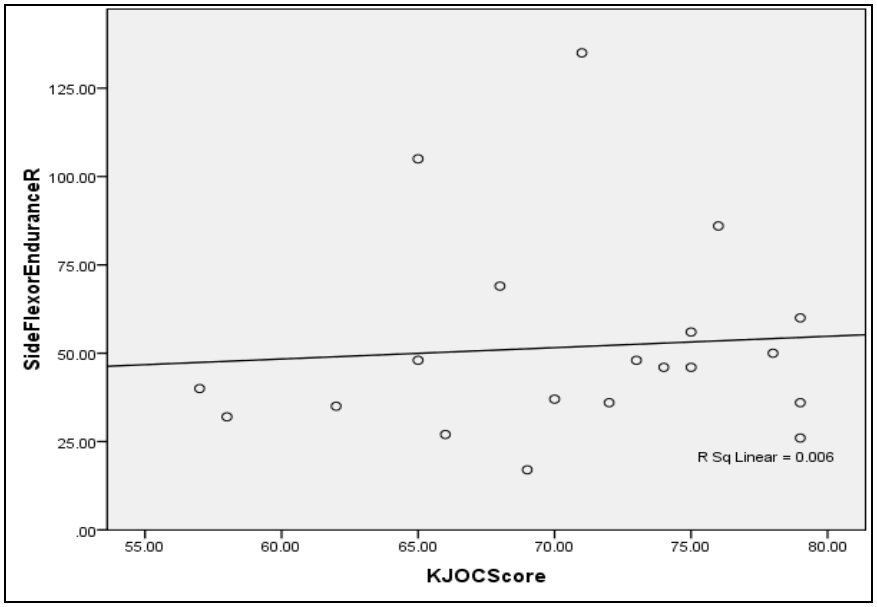

Fig 7: Scatterplot of KJOC score and right side flexor endurance

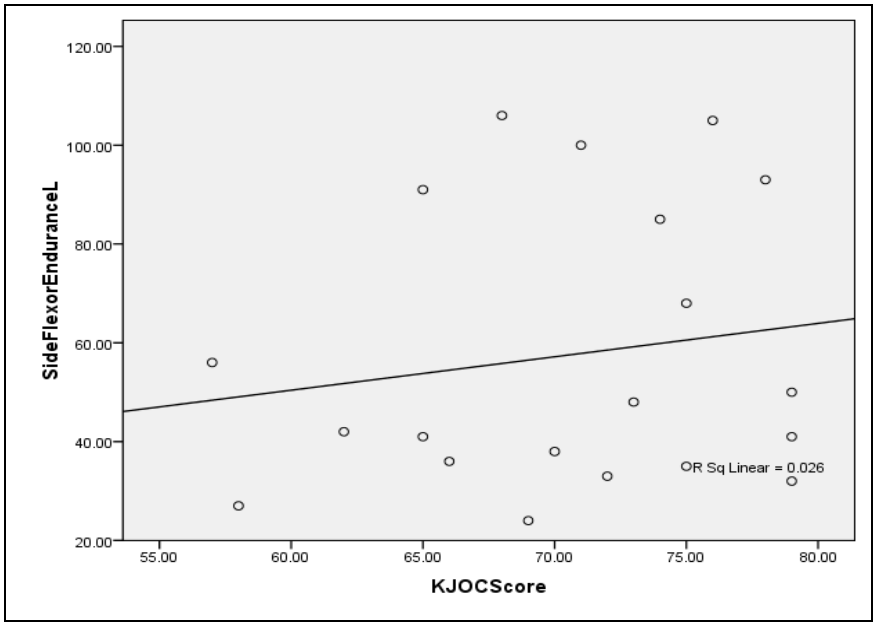

Fig 8: Scatterplot of KJOC score and left side flexor endurance

4. Discussion

There are many factors which induce shoulder dysfunction in cricketers. One among them may be lack of core endurance of trunk. Hence this study was carried out to find whether lack of core endurance correlate with shoulder dysfunction or not. Our results suggest that there is no statistical significant correlation between core endurance and shoulder dysfunction. This is in concordance with the results of Endo *et al*, where they reported no relationship between core muscle endurance and shoulder or elbow injury in junior high school baseball players. [13] Harrington *et al* in their cross-sectional study, examined shoulder pain and disability in Division I female swimmers and assessed core endurance in swimmers with and without shoulder pain and reported no significant differences between the groups [14] which is in consistence with our study. In contrast to our results, Radwan *et al.* [4] found that, balance deficiency was found in athletes with shoulder dysfunction, considering balance is an integral component of core. Different results may be due to the heterogeneous sample on their study (athletes who participate in baseball, football, or swimming) and the test that they utilized were modified (modified side plank).

Although there is a lack of evidence to support the correlation between shoulder dysfunction and core stability, there is information (including electromyography, EMG) to show how the core musculature (transverse abdominis, multifidus and other core musculature depending on the type of shoulder movements) is activated during upper extremity movements. In this favour, Brumitt recommended that core stability exercises should be included when an athlete is completing a rehabilitation program for their shoulder injury [15] This clinically sensitive but statistically insignificant correlations between measures of core stability and shoulder dysfunction might have occurred due to many reasons including modifications of tests to minimize the stresses and strains on the shoulder joint complex.

Several limitations of this study should be considered. First, small sample size was small and the participants were all young male recreational cricket players. Thus, further confirmation of these results must be done in larger and more diverse populations, including female athletes and age variation for the generalization of the results. Second, strict inclusion criteria and absence of dynamic multi-planer testing procedure. Third, the subjects with shoulder dysfunction who were participated in this study were not in the acute phase of injury and demonstrated overall high scores on the functional questionnaires. Lastly, modifying the stabilization procedure of straps stabilization in conventional testing with stabilization by the investigator in our study.

5. Conclusion

This study observes no statistical significant correlation between core endurance scores and shoulder dysfunction among recreational cricket players. Hence this study does not support the use of core stability training in prevention of shoulder dysfunction. But this study couldn't conclude about the effectiveness of core stability training in enhancing performance.

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