Correlation of hand grip strength, shoulder power and throwing distance in cricket players: cross sectional study

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***Abstract*—Throwing performance in cricket requires upper limb strength and coordination, particularly hand grip and shoulder function. This cross-sectional study examines the correlation of hand grip strength and shoulder power with throwing distance in male cricket players. Hand grip strength was measured using a Camry dynamometer, shoulder power with the Closed Kinetic Chain Upper Extremity Stability (CKCUES) test, and throwing distance with the cricket ball throw test.**

***Index Terms*— Hand grip strength, shoulder power, throwing distance, cricket players.**

I. INTRODUCTION

All The human hand is capable of performing complex and precise functions which can be divided into emotional activity, balancing activity, grasping abilities and manual dexterity. Hand grip is an important component of human function and is a unique feature that distinguishes humans from primate [1].

Cricket is one of the physically demanding sport comprised of several sectoral speciality that requires different skills and types of fitness. It requires excellent eye to hand co-ordination, upper extremity power, hand grip strength and the coordinated movements of shoulder, arms and wrists. Cricket is a game of endurance as well as strength and while batting, use of the forearm strength is very essential [2].

The hand does not function in isolation and is dependent on the integrity of the shoulder and elbow complexes to allow the appropriate positioning of the hand in space to complete the task and so to generate the necessary shoulder power and endurance [3]. Hand and forearm muscles are important in grip strength. Often overlooked, the strength of one's grip plays an important role in prevention of injuries and strength development [4]. Hand grip strength is the result of forceful flexion of all finger joints with maximum voluntary force that the subject is able to exert under normal biokinetic conditions [2]. Thus, the hand grip strength

reflects the overall physical strength of the cricket player [5]. Hand gripping represents the complex anatomical and functional structure of the hand [6,7].

Grip is defined as 'forceful act resulting in flexion at all the joints of the fingers along with thumb when used as a stabilizer to the object being held between the finger and the palm. Grip strength is referred to as a reliable and valid objective parameter to evaluate the functional integrity of the hand as the part of the musculoskeletal system. Grip strength is also evaluated in clinical settings as an indicator of disease activity [8,9,10]. It also assesses patients' initial limitations and provides a baseline for re- assessment of patients' progress [11].

The palmar pinch is used in about 60% of the activities of daily living (ADLs). It is a pinch of intermediate strength. It occurs between the thumb, index, and middle finger, for performing activities such as picking up a pen [7]. It requires the action of index and middle fingers' superficial flexor muscles and thenar muscles [12] to stabilize of the middle and the proximal phalanges of the thumb in flexion, respectively [13].

Handedness is an important factor that should be taken into consideration while measuring hand grip strength. A general rule often used states that the dominant hand is approximately 10% stronger than the non dominant hand. In our day to day life, we perform almost all the activities using dominant hand [14].

Cricket is almost certainly the most multifaceted and subtle team games amongst all the team games. There are mainly three departments in cricket namely (a) bating (b) bowling and (c) fielding, all are of equal implication and value, produced as a result of the wonderful amount of endurance and a variety of other motor components including throwing distance [15]. The thrown ball's speed and distance are directly related to the magnitude of the force used in throwing and the speed at which the ball is released. The quality of the throw, including throwing accuracy, throw distance, and throwing speed can have a significant effect on the game, especially when in a defensive position [16].

Throwing is one of the most important defensive skills [17]. Throwing is a movement skill in cricket. There are many aspects of throwing, making it a compound skill to increase proficiency in, skills such as producing ball velocity, ball movement, arm velocity, arm movement, distance, approach angle, target angle, etc. However, these aspects have small effect if the thrower cannot aim their throws precisely. Throwing correctness can be increased by improving the technique and practicing muscle memory which will result in accuracy for the athlete [15].

HGS is more closely related to rotational movements requiring high

torque, work, and velocity generating abilities, whereas movements requiring a high amount of technical precision and accuracy seem to be

less related to HGS. Similarly, once a threshold of HGS is attained, further competitive advantage may not be gained, especially where the coordination and timing of skilled actions is more important in bat and ball sport like cricket [18].

Grip strength is evaluated as a component of hand function in most of the sport. It is one of the best indicators of the overall strength of the limb [19]. Grip strength is the integrated performance of muscles that can be produced in one muscular contraction. It is widely accepted that grip strength provides an objective index of the functional integrity of the upper extremity [20]. The most common method of assessment for grip strength is the use of a handheld dynamometer. Hand held grip dynamometry is used to measure the muscular

force generated by the flexor mechanism of the hand and the forearm [21]. CAMRY dynamometer, belongs to spring type dynamometer, is the most often used device to measure handgrip strength in Chinese studies [22]

Normative data for hand grip strength based on age, gender and dominance are available from different continents for reference 65.783±3.365 kg in male cricket players [23].

The two most commonly injured structures in cricket are the rotator

cuff and the glenoid 1abrum. It should be clear that in order for a cricketer's shoulder to be pain free there needs to be a lot of dynamic strength and mobility of upper trunk and shoulder girdle [21]. Shoulder injuries in cricket players are extremely common as they involve excessive throwing actions while bowling and fielding. The glenohumeral joint is inherently unstable due to its bony configuration and the degrees of freedom of movement. Therefore, it is dependent to a great extent on ligaments and muscular structures to provide stability. High speed actions like throwing of ball requires frequent and synchronized activation of these stabilization mechanisms, especially the rotator cuff muscles [23]. Studies have shown that shoulder itself contributes 25% to the release of the ball while throwing or batting [24,25,26].

A kinematic analysis of the relationship between throwing distance and accuracy stated the role of shoulder stability in throwing motion. Many athletes get injured during the transition phase from "cocking to the acceleration" phase, where the stabilization and deceleration function of the long head of biceps plays an important role. It is however important that the shoulder girdle is stabilized while it is being protracted by the eccentric contractions of trapezius and rhomboid muscles[27]. Competitive sport like cricket demands a kinematic analysis of the relationship between throwing distance and accuracy [28].The good throwing technique can be supported by physical abilities, especially the upper body muscles' ability to support the underarm throwing and overhead throwing techniques[29].

The closed kinetic chain upper extremity stability (CKCUES) test score is a method for examination of the stability of shoulder joint. It doesn't require high level technique or clinical preparation, and it is cheap to conduct[30].

To measure power, particularly of the upper body, and evaluating throwing distance and technique, cricket ball throw test is used. The Cricket Ball Throw Test involves throwing a small ball (cricket ball or baseball) for maximum distance. This is an explosive power fitness test, which is easy and quick to perform for an individual[31].

II. REVIEW OF LITERATURE

Several studies have shown a strong link between hand grip strength, shoulder power, and throwing performance in athletes. Dr. Sathya P. et al. (2016) and others found a positive correlation between grip strength and shoulder power in cricket players, emphasizing their combined role in performance. Research by Kunvar Singh and Kanwar Singh showed that grip strength, height, and arm length significantly affect throwing distance. Studies by Hirea Shaukat and Pavan Talupuru linked grip strength with anthropometric factors and BMI. Mullerpatan and Diaz-Munoz established normative grip values and validated dynamometers, while Walankar and Lee confirmed the reliability of CKCUEST for upper limb stability. Overall, grip and shoulder strength are vital indicators of upper limb performance and athletic success

III. NEED OF THE STUDY

In cricket, throwing is one of the tasks that demands force generation from upper limb. Thus we find the need to assess two parameters of upper limb responsible for force generation i.e. hand grip strength and shoulder power. Through this study it will be determined that both the factors can be considered in cricketers for throwing ball.

Also, several studies have been done on hand grip strength and shoulder power, but there is less availability of literature of correlation with throwing distance. Hence, we want to augment this study so that more literature will substantiate better relationship between hand grip strength, shoulder power and throwing distance.

IV. AIMS AND OBJECTIVE OF THE STUDY

Aim of the Study:

To determine the correlation of hand grip strength and shoulder power with throwing distance among cricket players.

Objectives of the study:

The objective of the study is:

1. To evaluate hand grip strength with dynamometer.
2. To evaluate shoulder power with closed kinetic chain upper extremity stability (CKCUES) test in shoulder joint.
3. To evaluate throwing distance in cricket players
4. To establish correlation between hand grip strength and throwing distance
5. To establish correlation between shoulder power and throwing distance

V. HYPOTHESIS

Null hypothesis (H0):

($H0^1$): There is no correlation of hand grip strength and throwing distance in cricket players.

($H0^2$): There is no correlation of shoulder power and throwing distance in cricket players.

Alternative hypothesis (H1):

($H1^1$): There is a correlation of hand grip strength and throwing distance in cricket players.

($H1^2$): There is a correlation of shoulder power and throwing distance in cricket players.

VI. MATERIALS AND METHODOLOGY

Study Design- Cross-sectional study[41]
Sample Size- The study was carried out on 91 subjects.
Source of Data- Various Cricket Academies from Anand and Vadodara

- Anand Cricket Association, Anand
- Elecon Cricket Academy, Anand
- Vadodara Cricket Association, Vadodara
- Vadodara Cricket Academy, Vadodara
- Akota Cricket Club, Vadodara
- Kiran More Cricket Academy, Vadodara

Study Duration- 1year
Sampling Method:- Purposive sampling[41]
Inclusion Criteria

i. Age of 19-24 years
ii. Male players
iii. Playing experience of cricket for 2 years or more
iv. Regular in practice sessions (5 days a week x 2-3 hours per day)
v. Players who are willing to participate in the study

Exclusion Criteria

i. Pathology or trauma or surgery to upper extremity and cervical spine in past 1 year
ii. Subjects having any systemic illness

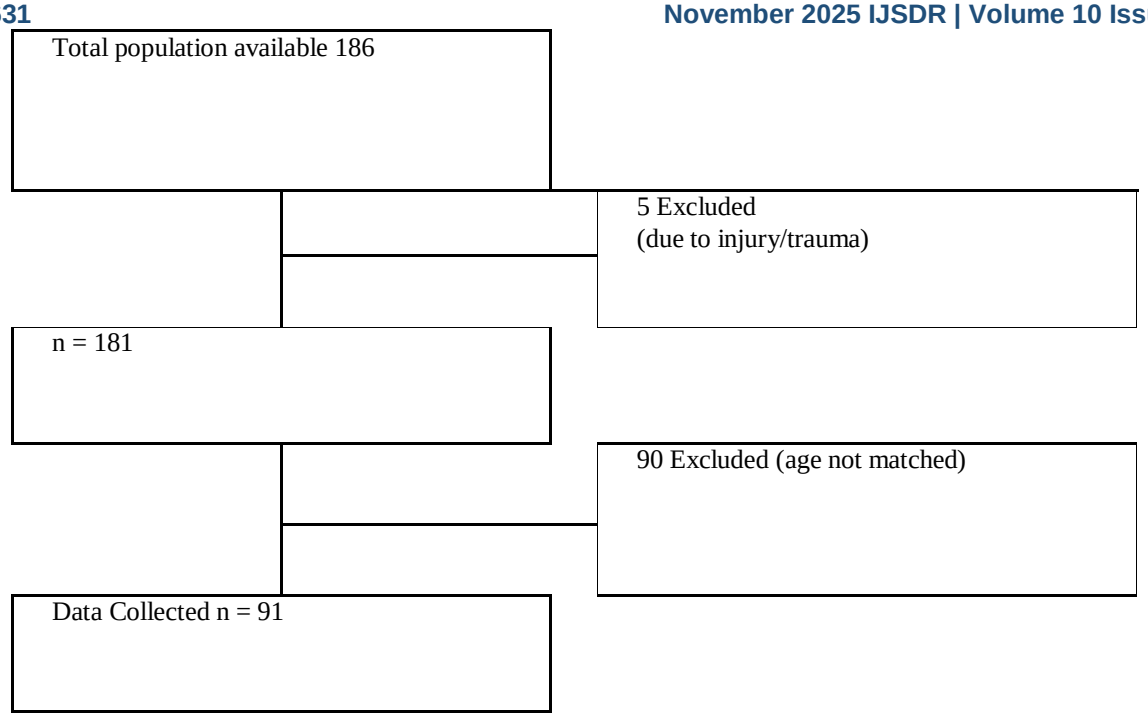
Materials used:

1. Paper
2. Pen
3. Camry dynamometer
4. Cones
5. Measure tape
6. Weighing machine

METHOD OF DATA COLLECTION

Consent for the study

Permission for pursuing the research problem was obtained from the human resource and ethics committee of Shree B.G. Patel College of Physiotherapy, Anand on 12/09/2023. Participants were selected based on the eligibility criteria. Complete explanation of the study process was given to all the participants and an informed consent form was obtained. They were informed that participation was completely voluntary without positive or negative consequences. They were also informed about confidentiality of the data and that their identities would remain anonymous in the article, and data would not be shared with any third party.



Procedure

Participants were provided with subject information sheets, which they were asked to fill. Participants were familiarized with the technique of test performance by demonstration. The grip strength was assessed using Camry dynamometer. Shoulder power was measured using closed kinetic chain upper extremity stability (CKCUES) test, and throwing distance was measured using cricket ball throw test.

Outcome Measures

CAMRY DYNAMOMETER

A Camry Dynamometer was used to evaluate the grip strength of the participating athlete. The subjects were made to sit with their shoulder adducted and neutrally rotated, elbow flexed at 90°, forearm and wrist in neutral position. Subjects were asked to hold dynamometer with dominant hand, at their side without touching rest of the body, and squeeze it forcefully (figure-1.1 and figure 1.2). Three trials were given, and the mean of the three trials was calculated and taken as mean grip strength. Initial instructions with explanation and demonstration were given to the subjects[!5].

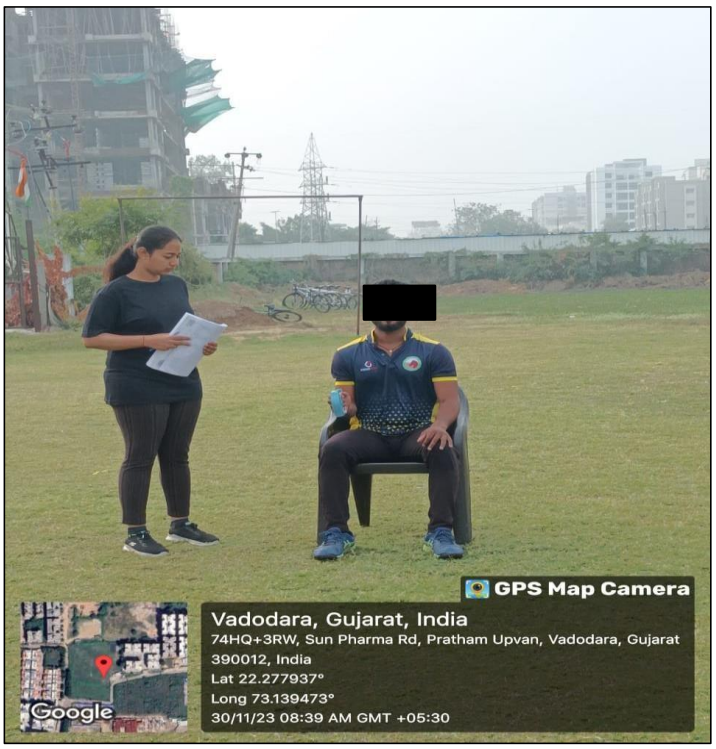


Figure-1 front view

Figure- 1.2 side view

(Figure-2 showing the set up for calculating throwing distance through cricket ball throw test)

CRICKET BALL THROW TEST

The Cricket Ball Throw Test involves throwing a cricket ball for maximum distance. The test is performed to measure power, particularly of the upper body, and evaluates throwing distance and technique.

Equipments required: Standard leather cricket ball, cone or marking tape, measure tape, clear open area for testing.

Pre-test: The test procedure was explained to the subjects and screening of health risk was done. Marker cones were placed for the starting line and target area. An appropriate warm-up for 10-15 minutes in form of running and general body movement exercises were performed.

Procedure:

Line was marked using two cones as the line where the subject has to throw from. Participants were allowed a 10 m run-up. Following the run-up, participants have thrown the ball without crossing the line. If the line was crossed the throw was deemed as foul (figure 2). Two practice throws were allowed and three measurements were made. Average of three measurements was considered for analysis.

Scoring: The distance from the starting line to where the ball first lands was recorded. The measurement is recorded to the nearest meter. The best result of three throws was recorded[37].

CLOSED KINETIC CHAIN UPPER EXTREMITY STABILITY (CKCUES) TEST

The closed kinetic chain upper extremity stability (CKCUES) test is a performance test that provides quantitative data (score) for upper extremity tasks in closed kinetic chain. The test consists of counting how many times, during fifteen seconds, the subject assuming a push–up position is able to touch his supporting hand with the swinging hand. Two strips of athletic tape with a width of 1.5 inches were placed parallel to each other 36 inches apart, as measured by a standard tape measure on a tiled floor or flat surface ground. The procedure was explained and demonstrated to the subjects. The starting position for the test was with one hand on each piece of tape while assuming a pushup position. The subjects were instructed that from the starting position they were to use one hand to reach across their body and touch the piece of tape lying under the opposing hand. After touching the tape, the hand was returned to the original starting position. The subject then performed the same movement with the other hand (figure-3). Touches were counted as every time the hand reached across the subject's body and touched the tape in the total time of 15 seconds. Three trials were taken and the average of all the three touches was calculated. Each subject performed a warm up trial followed by three trials of the test with a rest period of 45 seconds between trials. The average of the three trials was used in the data analysis. During the test, subjects had to keep a straight flat back, keep their hands and shoulders in a perpendicular position so that body weight was sufficiently distributed over the upper limbs, and the knees must never touch the ground.

The test required two examiners. One examiner counted the number of times the subject touches hands. The other used a stop watch to begin and end the test. Shoulder power was calculated by following formula:

Power = 68% weight*average no. of lines touched/15[1,14]

Figure-3

VII. DATA ANALYSIS

- All data were analyzed through SPSS version 25
- Normalcy of data was found through Kolmogorov-Smirnov test
- Pearson Correlation test was used for testing correlation between hand grip strength and shoulde

VIII. RESULT

- All data were analyzed through SPSS version 25
- Normalcy of data was found through Kolmogorov-Smirnov test
- Pearson Correlation test was used for testing correlation between hand grip strength and shoulder power.

BASELINE DATA

No. of Participants (n)	91
Age (years) mean ± Standard Deviation	20.5±0.70
Weight (kg) mean ± Standard Deviation	62.62±10.39
Dominant side (left) (n)	19
Dominant side (right) (n)	72

Table-1

Table-1 Shows the baseline data of all the subjects n=91, age (years) Mean and SD= 20.5±0.70, Weight (kg) mean and SD = 62.62±10.39, No. participants with dominant side (right)=72, No. participants with dominant side (left)=19

DESCRIPTIVES

Variables	**Mean and Standard Deviation**	**A**
Hand grip strength (kg)	37.99 ± 8.961	0.200*
Shoulder power (N/m)	104.10 ± 23.648	0.173
Throwing distance (m)	61.94 ± 9.059	0.200*

Table-2

a=significance; *=lower bound of true significance

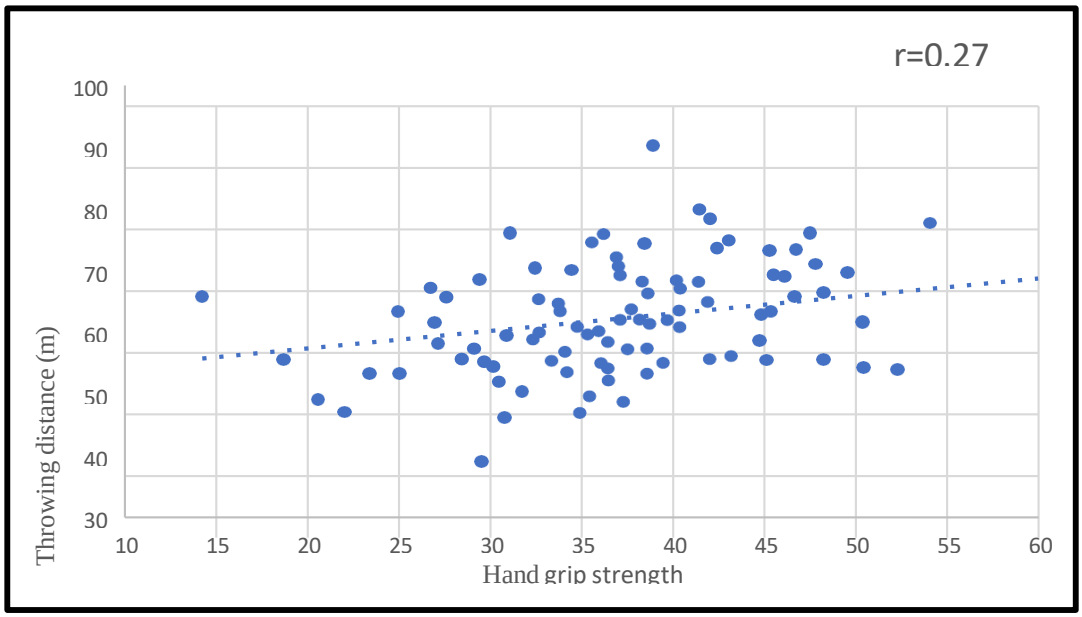
Table-2 Shows descriptive of the mean and standard deviation of the data. Mean ± standard deviation of three outcomes handgrip strength, shoulder power and throwing distance among 91 male cricket players aged between 19-25 years. Hand grip strength - mean and standard deviation is 37.99 (±8.9961); shoulder power - mean and standard deviation is 104.10 (±23.648); throwing distance - mean and standard deviation is 61.94(±9.059)

CORRELATION

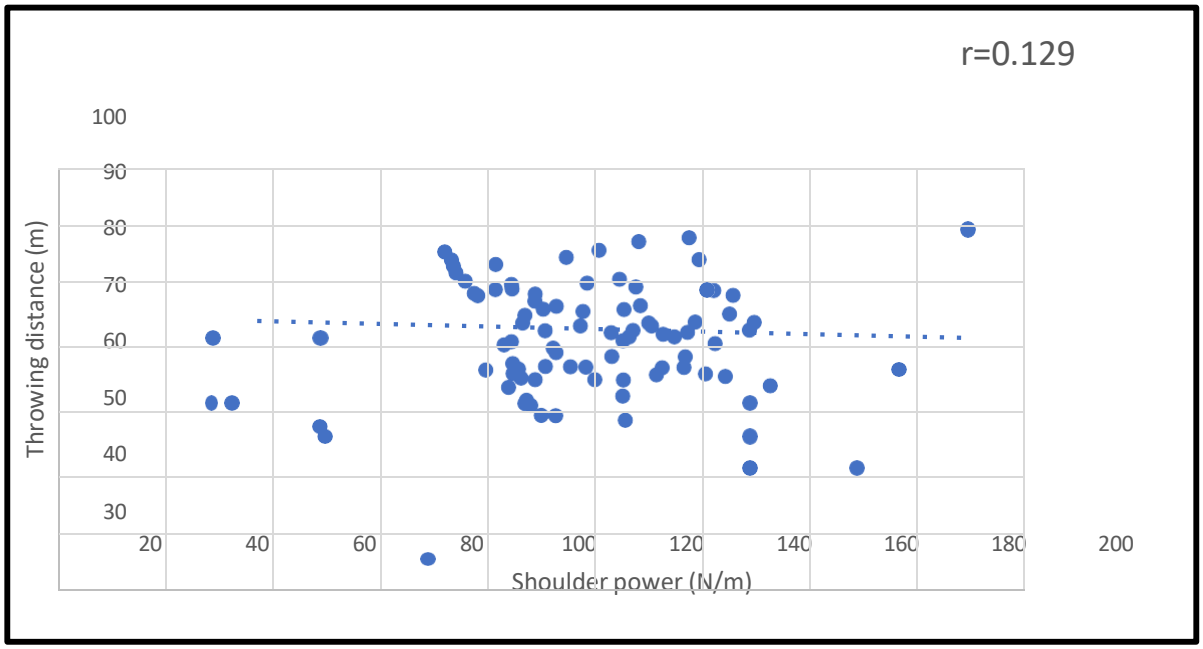
Outcomes		**Throwing distance (m)**
Grip strength (kg)	r value	0.275
	p value	0.008
Shoulder power (N/m)	r value	0.129
	p value	0.225

Table-3r=Pearson correlation, p value=significance, 95% confidence interval

Table-3 shows result of data analysis performed using correlation analysis. It is found that there is significant relationship between hand grip strength and throwing distance with correlation of (r=0.275) and significance level of (p=0.008). No correlation was found in relationship between shoulder power and throwing distance with correlation of (r=0.129) and significance level of (p=0.225)



Graph-1 The above scatter diagram shows that there is a positive correlation between hand grip strength and throwing distance



Graph-2 The above scatter diagram shows that there is no correlation between shoulder power and throwing distance

IX. DISCUSSION

The aim of the present cross-sectional study was to find correlation of hand grip strength and shoulder power with throwing distance among male cricket players from age 19 – 25 years who were regularly practicing for 5 days a week, 2-3 hours per day from 2 years or more and the participants with absence of any impairment affecting upper extremity function, trauma or surgical intervention past one year were taken. 186 data were collected from various cricket academies of Anand and Vadodara and matching the inclusion criteria, data analysis was done for 91 subjects.

Handgrip strength was assessed with Camry dynamometer for dominant hand, shoulder power was assessed with CKCUEST and throwing distance was assessed with cricket ball throw test for which mean and standard deviation was (37.99 ± 8.961); (104.10 ± 23.648) and (61.94 ± 9.059) respectively. The result showed positive correlation between hand grip strength and throwing distance with r=0.275 and p value = 0.008. There was no correlation between shoulder power and throwing distance with r=0.129 and p value= 0.225

The study done by et al Dr. Sathya (2016) found that when hand grip strength was assessed in intercollegiate male cricket players from age group 17-19 years, mean hand grip strength was significantly increasing in every consecutive year from 17-19 years due to skeletal maturity age. In the present study hence, cricket players after 19 years of age group were taken[21].

Similar result of data analysis was performed using correlation analysis, it was found that there was a significant relationship between arm muscle strength and throw distance in softball games with a correlation value of 0.893 and a significance level of 0.000 which shows no significant relationship between grip strength and throwing distance in softball, with a correlation value of 0.197 and a significance level of 0.448 (et al Gustina M Angitta, 2021)[37]

In comparison study of comparing digital camry dynamometer to the hydraulic jammar dynamometer for use in healthy population showed hand grip strength of 32.15±9.96 kg with the Jamar dynamometer and 29.95±9.18 kg with the Camry device with the significance level of Camry instrument ($p < 0.05$)[30]. In the present study we took digital camry dynamometer for assessing hand grip strength which is a reliable and valid tool.

Reliability and validity study of closed kinetic chain upper extremity stability test which we used to assess shoulder power was done by Dong-Rour Lee in 2015 stated very high reliability of the CKCUES test (ICC=0.97). The correlations between the CKCUES test and maximum grip strength (r=0.78–0.79), and the peak torque of internal/external shoulder rotation (r=0.87–0.94) indicated its high validity. The CKCUES test can be thus used for clinical tests on upper limb stability at low price[40].

X. CONCLUSION

The present study concludes that there is positive correlation between hand grip strength and throwing distance which supports alternate hypothesis ($H1^1$) and there is no correlation between shoulder power and throwing distance which supports null hypothesis ($H0^2$). Though upper extremity as a whole contributes for throwing distance efficacy, but statistical significance was found for correlation of throwing distance with hand grip strength and not with shoulder power.

XI. LIMITATIONS

1. There were limited reference regarding correlation of hand grip strength and shoulder power with throwing distance
2. Smaller sample size
3. The study was carried out in off season
4. The study only focuses on measuring the throwing distance and does not measure other components of throwing skills such as throwing accuracy and throwing speed.

XII. STRENGTH OF THE STUDY

The sport of cricket comprises varied biomechanics in the whole body while playing on field, in practice session as well as in training which recruits different joints as per demand. The present study hence, highlights the importance of correlation of hand grip strength and throwing distance in cricketers that is suggestive of more emphasis to be placed on improving hand grip strength for improving throwing distance.

XIII. FUTURE RECOMMENDATIONS

1. The study can be carried out in female cricket athletes
2. The study can be carried out on different age groups
3. Correlation can be found among batsman, baller and allrounder separately
4. The study can be carried forward with assessing hand grip strength in various position of hand (for e.g. elbow in 0^{o})
5. Similar study can be carried out with assessing shoulder power with medicine ball throw test

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