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Effect of core strengthening exercises on throw velocity in cricket players

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Abstract
Background and purpose: Core strengthening exercises have been showed improvement in players playing of various sports, such as baseball players, athletes, handball players, etc. Core muscles are the origin of power in the body. Having a strong core facilitate every player in every sport and game activities. The objective of the study was to find out the comparative effectiveness of core strengthening exercises on throw velocity in cricket players.
Method: This study was an Experimental study design. The samples were selected on the basis of convenient sampling with random allocation of samples. 50 subjects were selected, in the age ranging from 15-20 years were assigned into two groups; Group A Core strengthening exercises with daily workout (25 subjects) and Group B Daily workout (25 subjects) 3 times in a week for 6 weeks. Pre and Post throw velocity were measured, by standardized formula and noted down. At the end of the 6th week, the pre and post throw velocity were compared of both groups.
Results: Results of the present study demonstrated that both the interventions in experimental and control group were found to be individually effective in improving ball throw velocity of cricket players.
Conclusion: The present study concludes that both the interventions in experimental and control group were found to be individually effective in improving ball throw velocity of cricket players. But while compared the posttest outcomes in between the groups, the intervention of core strengthening exercises in experimental group was found to be better on improving the ball throw velocity of cricket players than the cricket players treated with daily workout in control group.
Implication: Core strengthening exercises are effective in improving the ball throwing performance in cricket players.

Keywords: Core strengthening exercises, cricket players, throw velocity

Introduction
Batting, bowling and fielding can be considered to be the three main components of cricket [1]. Sports that demand throwing motions can be considered rotational power sports because of the necessity of explosive movements in either the transverse or oblique planes [2].
Throwing performance is vital in most of overhead throwing sports such as baseball, cricket, handball, etc. Throwing performance contain two key components: Throwing speed and throwing accuracy [3]. In cricket, resultant ball velocity and accuracy affect the time required for the ball to be returned to the stumps from the field. Velocity is an imitative of displacement over time. Hence, previous study shows an increase in velocity results in a decreased flight time, thus potentiating the fielding side's ability to accomplish run-outs and reduce run-scoring opportunities for the opposition. A speed-accuracy alliance has been reported to exist during the implementation of the overhead throw, such that increases in velocity result in improved accuracy until a critical velocity is reached, at which point further increases in velocity result in decreases in throwing accuracy. This outcome is assigned to the learning effect, as Indermill and Husak suggest that 75 % of maximum throwing velocity is the speed at which most practice occurs [4].
In cricket, fast bowling has been associated to both upper body and lower body neuromuscular performance. Higher shoulder extension strength was substantially positively correlated to ball release velocity, while neuromuscular performance produced in the lower limbs were associated with increased ball release velocities. Cricket pace bowling performance is reliant on both speed and accuracy [5].

Core musculature in our body is to maintain the stability of the body. It improves sports performance by enhancing the stiffness of the trunk which enables an individual to produce greater torque while executing anybody movement [5].

In most of the sports for any movement torque production is started from the bigger muscles and subsequently distributed to the smaller muscles. Previous study reports, the muscular torque production is highly dependent on the core strength ability of the individual. For a sport like cricket, which includes movements like throwing, hitting are not only the result of upper arm strength, this is the transformation of torque from bigger muscles to the smaller muscles and here the rule of core strength is of great importance. For the throwing movement the core muscles are fully responsible for the proper positioning of shoulder girdle [6]. And hence, in our study the aim was to find out the effectiveness of core strengthening exercises on throw velocity.

Core muscles are the origin of power in the body. Having a strong core facilitate every player in every sport and game activities [6]. Since cricket is a team sport, all of the players are enforced to be in action from 3 hours to 5 days match, the game needs a high level of fitness for a professional player to perform effectively. An effective player require great balance and core strength, speed for running between the wickets and in the field and fast bowlers specifically require great speed and power. Core stability is the foundation for detonation movements and control (agility, balance and control). In cricket terms, you become more stable while batting, have better control while bowling and become substantial in your ability to catch and throw the ball [7]. The core functions as the central link between the upper and lower extremities, and stability of this region is proposed to be a essential for optimal athletic performance and injury prevention [8]. A weak core is believed to cause conversion in the transfer of energy, resulting in decreased sport performance and risk of injury to a weak or underdeveloped muscle group [9].

Core strengthening has been assisted as a preventive regimen, as a form of rehabilitation and as a performance enriching program for various lumbar spine and musculoskeletal injuries. Though stabilization exercises have become a considerable focus of spinal rehabilitation as well as of prophylactic core such as sports injury prevention [10].

If the strength of muscle is increased, it can increase performance of the individual. So, greater the performance highly the chance of winning the game and increase in ranking level [11]. Core stability is gained through stabilization of one's torso, thus allowing optimal production, transfer and control of force and motion to the terminal segment during an integrated kinetic chain activity. The core musculature functions differently than the limb musculature in that core muscles often co-contract, establishing the torso like that all muscles becomes synergists-examples in a wide variety of training and athletic activities are provided [12].

Throwing depends on overhead baseball pitching. This motion is thought to be secular to the overhead throw employed by cricketers, however assessable differences in throwing velocity, accuracy and biomechanics have been identified. Specifically, cricketers have less elbow flexion during the stride phase of throwing resulting in a lower vertical release direction of the ball [19].

Throwing performance is a consolidation of both throwing speed and accuracy. The acceptance was that these components are inveigled by both player physiology such as muscle strength, throwing technique or biomechanics. Developing muscle strength and power of the upper and lower limbs had been found to be efficient in increasing throwing performance in sports such as baseball, handball and others [20].

Most of the scientific investigation into the biomechanics of men's cricket had been executed on the technique of fast or fast-medium bowling. It may be because it was extensively considered that fast bowling in cricket is one of the non-contact activities most perceptible to injury, as proved by the almost epidemic proportions which injuries to the lower back had reached between fast bowlers. Because of the related lack of published results and evaluation of the forces involved in fast bowling, they focus mainly on the kinematics of the fast bowling technique. Appropriate emphasis was placed on the effect of different kinematic parameters upon the ball release speed. For the determination of this review, the action is split into the four distinct stages of the run-up, the pre-delivery stride, the delivery stride and the follow through [21].

To achieve any movement the most essential aspect is the dynamic balance or stability. Core stability is the capability to control the position and motion of the trunk beyond the pelvis to confess optimum production, transfer and control of force and motion to the peripheral segment in combined athletic activities (Kibler W.B). It was speculate that a strong core allows an individual the full transfer of forces created from the ground among the lower extremities, the torso and finally to the upper extremities and sometimes an appliance. So, it becomes very essential to encourage the core muscles of our body to get the maximum out of the performance [23].

Core strength training had an allowance on better posture, more control improved, more powerful performance, injury prevention and rehabilitation, increased protection and "bracing" for your back, a more reliable center of gravity, a more reliable platform for sports movements [23].

Previous studies show that relationship between speed and accuracy is important in cricket, as a throw with high velocity is of little value if increases in velocity are produced at a detriment to accuracy, as the specific target of a cricket throw is small. And cricket pace bowling depends on both speed and accuracy. Core stability is responsible for agility, balance and control. And the purpose of this study was to know the effect of core strengthening exercises on throw velocity in cricket players.

Methodology

Subjects were randomly allocated and assigned either to group A or group B with 25 subjects in each group respectively. 50 small chits were used with 25 pieces having the words group A and the protocol of core strengthening exercises with daily workout allocated to them. 25 pieces having the words as group B and the protocol of daily workout allocated to them.

Group A - Experimental Group

In this group subjects will follow Core strengthening exercises with daily workout, for 3 days per week for 6 weeks. 25 subjects was in this group, both male and female. All the subjects was taught core strengthening exercises,

which they had to follow for the 6 weeks along with their daily workout. Before starting the session the throwing velocity had been measured. Throwing velocity had been measured by recording (in mobile) the balling of the individual and then calculating it by the standardized formula (speed=dist/time). The velocity of each and every individual was noted down on the data collection sheet. This procedure had been done for each and every individual separately. After measuring the pre-throwing velocity, all the individuals was asked to perform the daily workout first and then core strengthening exercises together Ely in group. The post-throwing velocity had been measured after the session individually. And respectively noted down on the data collection sheet. This procedure is carried out for 3 days in a week for total 6 weeks and the data is preserved.

Fig 1: Group Daily workout

Fig 2: Lunges

Fig 3: Side Lunges

Fig 4: Star Jumps

Fig 5: Twist Rotation

Fig 6: Squatting

Fig 7: Chest Press

Fig 8: Pull Shot

Fig 9: Swiss Ball Plank

Group B - Control Group

This group is the control group, in this group subjects followed the daily workout session in group for 3 days per week for 6 weeks.25 subjects was in this group including both male and female. All the subjects was taught daily workout exercises, which they had to follow for the 6 weeks. Before starting the session the throwing velocity had been measured. Throwing velocity had been measured by recording (in mobile) the balling of the individual and then calculating it by the standardized formula (speed=dist/time). The velocity of each and every individual was noted down on the data collection sheet. This procedure had been done for each and every individual separately. After measuring the pre-throwing velocity, all the individuals was asked to perform the daily workout exercises together Ely in group. The post-throwing velocity had been measured after the session individually. And respectively noted down on the data collection sheet. This procedure is carried out for 3 days in a week for total 6 weeks and the data is preserved.

Fig 10: Daily Group Workout

Outcome Measures

Throwing velocity is calculated by the standard formula:

Velocity = Distance/Time

Calculating ball speed is to time how long it takes for the ball to travel the length of the lane. Using a stopwatch, we need to observe the time how long it takes from ball release till pin strike. The ball speed is calculated dividing the distance by time.

Results and Interpretation

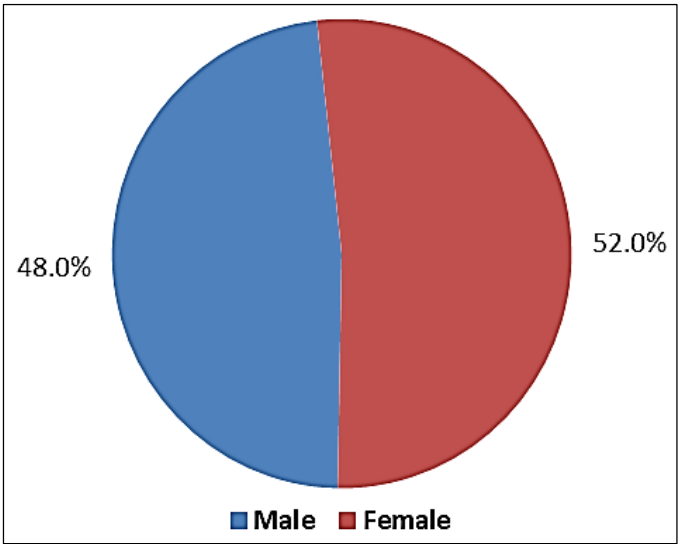
Table 1: Distribution of cricket players according to gender in both groups

Sr. No.	Gender	Group	
		Experimental	Control
1.	Male	12(48.0%)	13(52.0%)
2.	Female	13(52.0%)	12(48.0%)
		Chi-Square value = 0.080 DF = 1, p>0.05, NS	

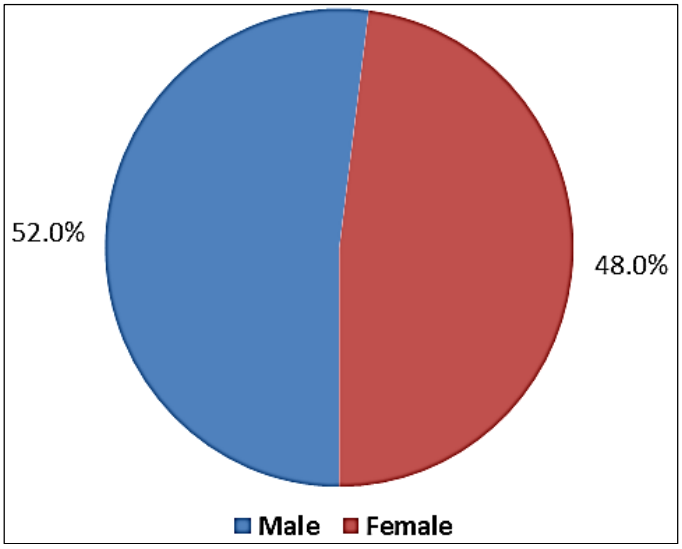
NS - Not Significant. I.e. p>0.05.

The above table shows the proportion of Cricket players according to gender. In experimental group, 12(48.0%) of the cricket players were males and 13(52.0%) of them were females. In control group, 13(52.0%) the cricket players were males and 12(48.0%) were females. There was more or less same proportion of cricket players found according to gender in both the groups and it was found to be statistically not significant (χ^2=0.530,, df=1)at 5% level i.e., p>0.05. It

evidenced the baseline characteristic of gender is homogeneous in both the groups. The following pie diagrams depicted the proportion of Cricket players according to gender.



Graph 1a: Gender pro-portion of subjects in experimental group



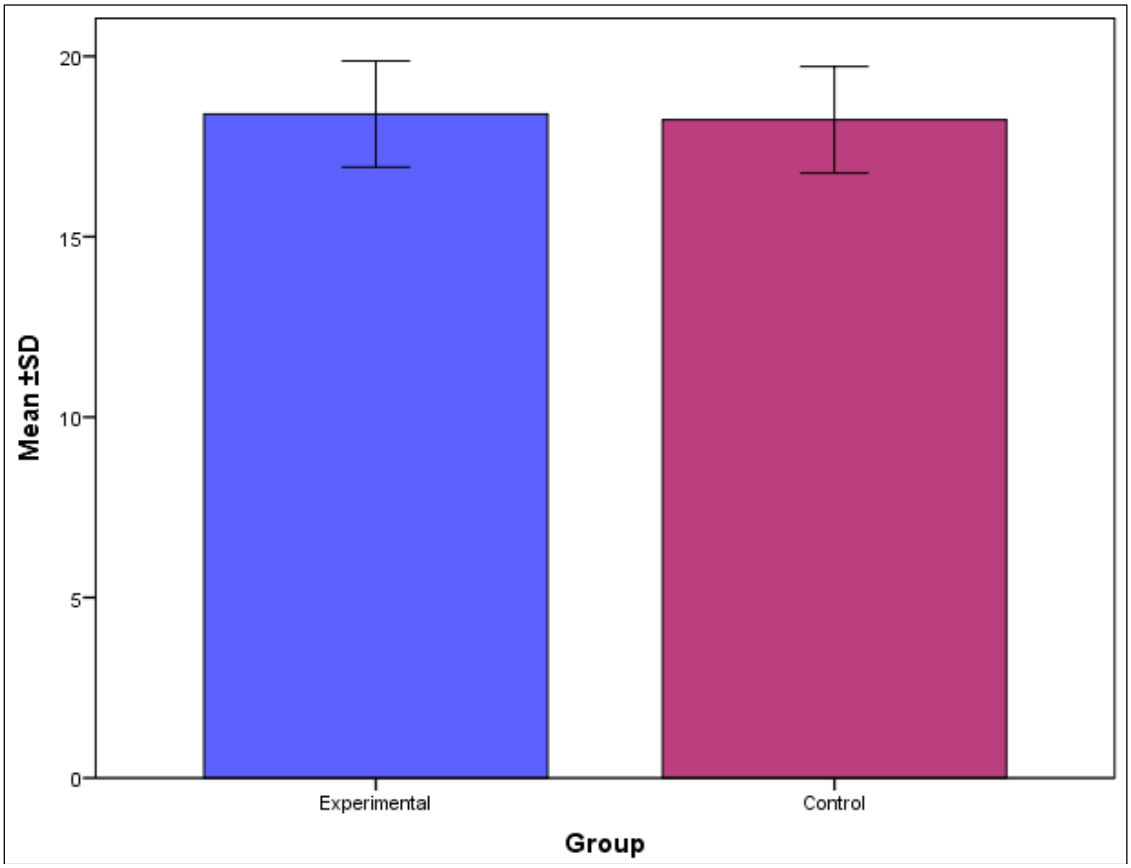
Graph 1b: Gender pro-potion of subjects in control group

Table 2: Range, mean and SD of age of the Cricket players sin both the groups

Sr. No.	Variable	Experimental		Control		Unpaired T-Test
		Range	Mean ± SD	Range	Mean ± SD	
1	Age in years	16-20	18.40±1.47	16-20	18.24±1.48	T=0.703, p>0.05, NS

NS-Not significant i.e. p>0.05.

The table 2 presents the outcomes of age in years of the cricket players in both the groups. In experimental group, the subjects were ranging within the age of16-20with mean and SD of18.40±1.47. In control group, the subjects were ranging within the age of 16-20with mean and SD of 18.24±1.48. The unpaired t-test was carried to compare the means, which was found to be not significant at 5% level (i.e., p>0.05). It revealed that the baseline characteristic of age was similar in both the groups.



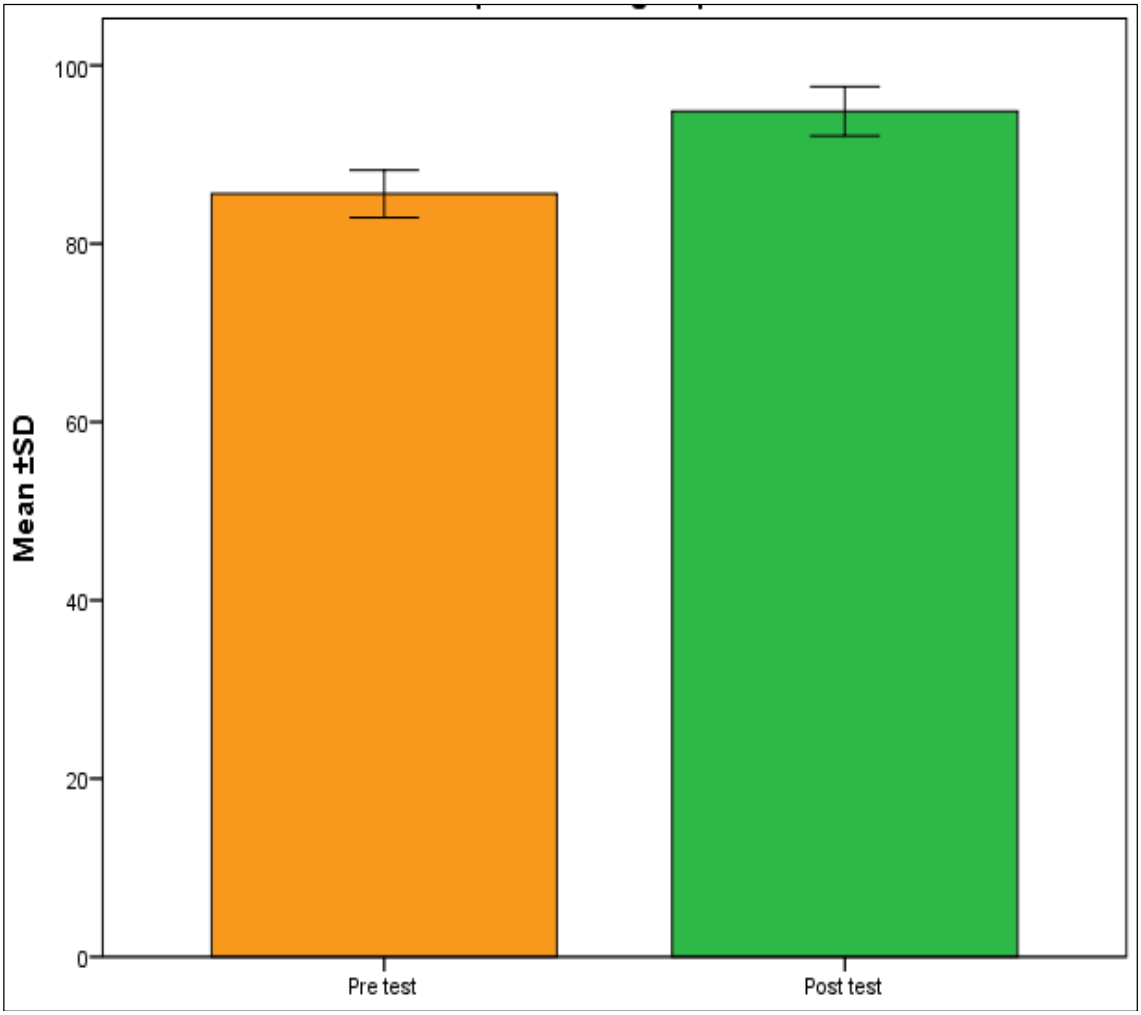
Graph 2: Mean and SD of age of cricket players in both the groups

Table 3: Range, mean and SD of outcome measures of cricket player sin experimental group

Sr. No.	Outcome measures	Experimental				Paired T-Test	P-Value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1.	Ball throw velocity (Kph)	82-90	85.60±2.68	90-99	94.84±2.76	T=25.817*	p<0.001

Note: * denotes-Significant (p<0.05), T-paired T-Test.

The above table-3 shows the pre and post-test outcomes of outcome measure of ball throw velocity cricket players in experimental group. In pre-test, the ball throw velocity was ranging within 82-90 with mean and SD of 85.60±2.68. But in post-test, it was found to be increased to the range 90-99 with mean and SD of 94.84 ± 2.76.The parametric test for comparison of dependent outcomes, the paired t-test was carried out and it was found to be significant (p<0.001). It evidence the there is a significant increase in ball throw velocity among cricket players treated with core strengthening exercise in experimental group.



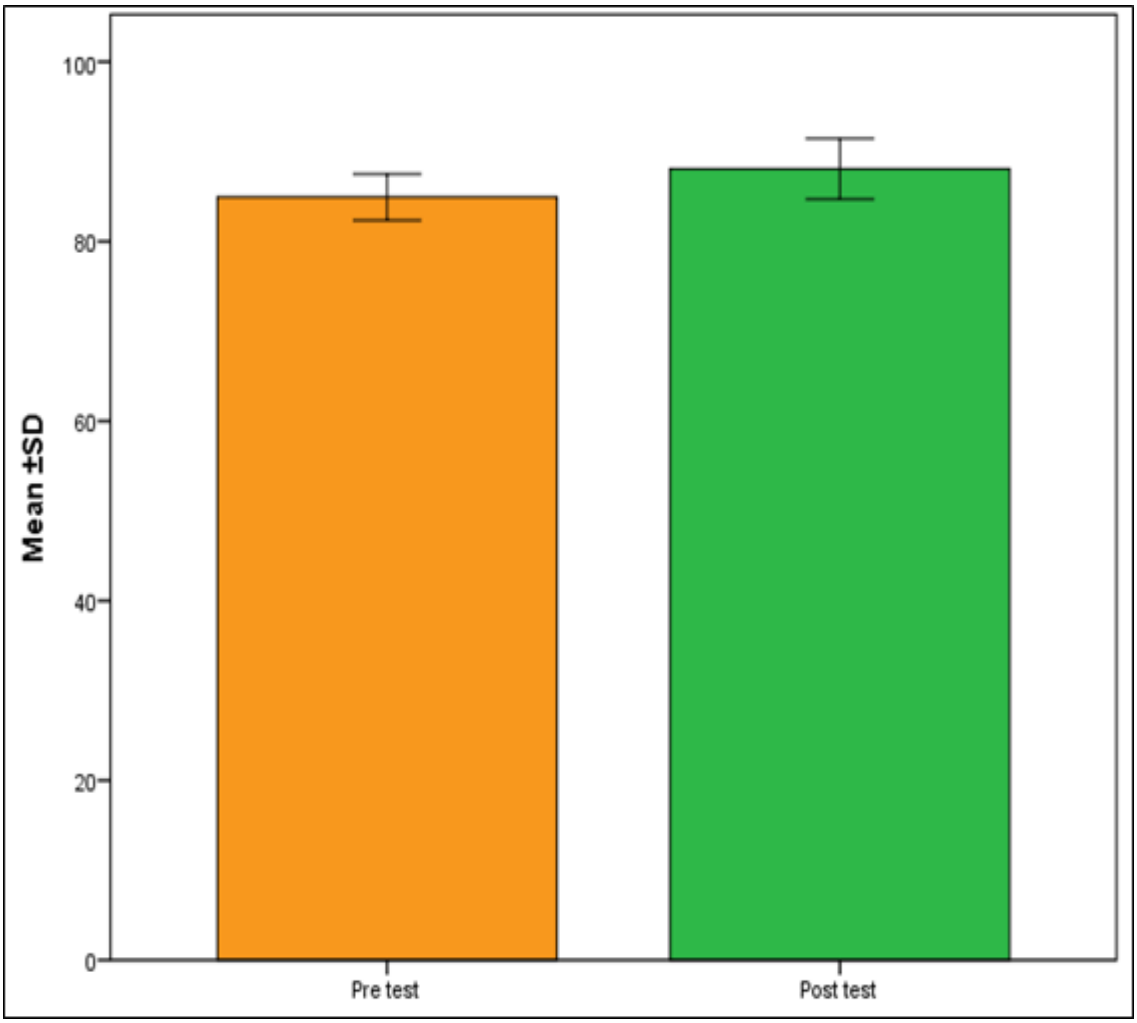
Graph 3: Mean and SD of pre and post-test ball throw velocity of cricket players in experimental group

Table 4: Range, mean and SD of outcome measures of cricket players in control group

Sr. No.	Outcome measures	Experimental				Paired T-Test	P-Value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	Ball throw velocity (Kph)	82-90	84.92±2.58	84-98	88.08 ± 3.36	t=8.802*	p<0.001

Note: *denotes-Significant (p<0.05), T-Paired T-Test

The above table-4 shows the pre and post-test outcomes of outcome measure of ball throw velocity cricket players in control group. In pre-test, the ball throw velocity was ranging within 82-90 with mean and SD of 84.92±2.58. But in post-test, it was found to be increased to the range 84-98 with mean and SD of 88.08 ± 3.36. The parametric test for comparison of dependent outcomes, the paired t-test was carried out and it was found to be significant (p<0.001).
It evidence the there is a significant increase in ball throw velocity among cricket players treated with daily workout in control group.

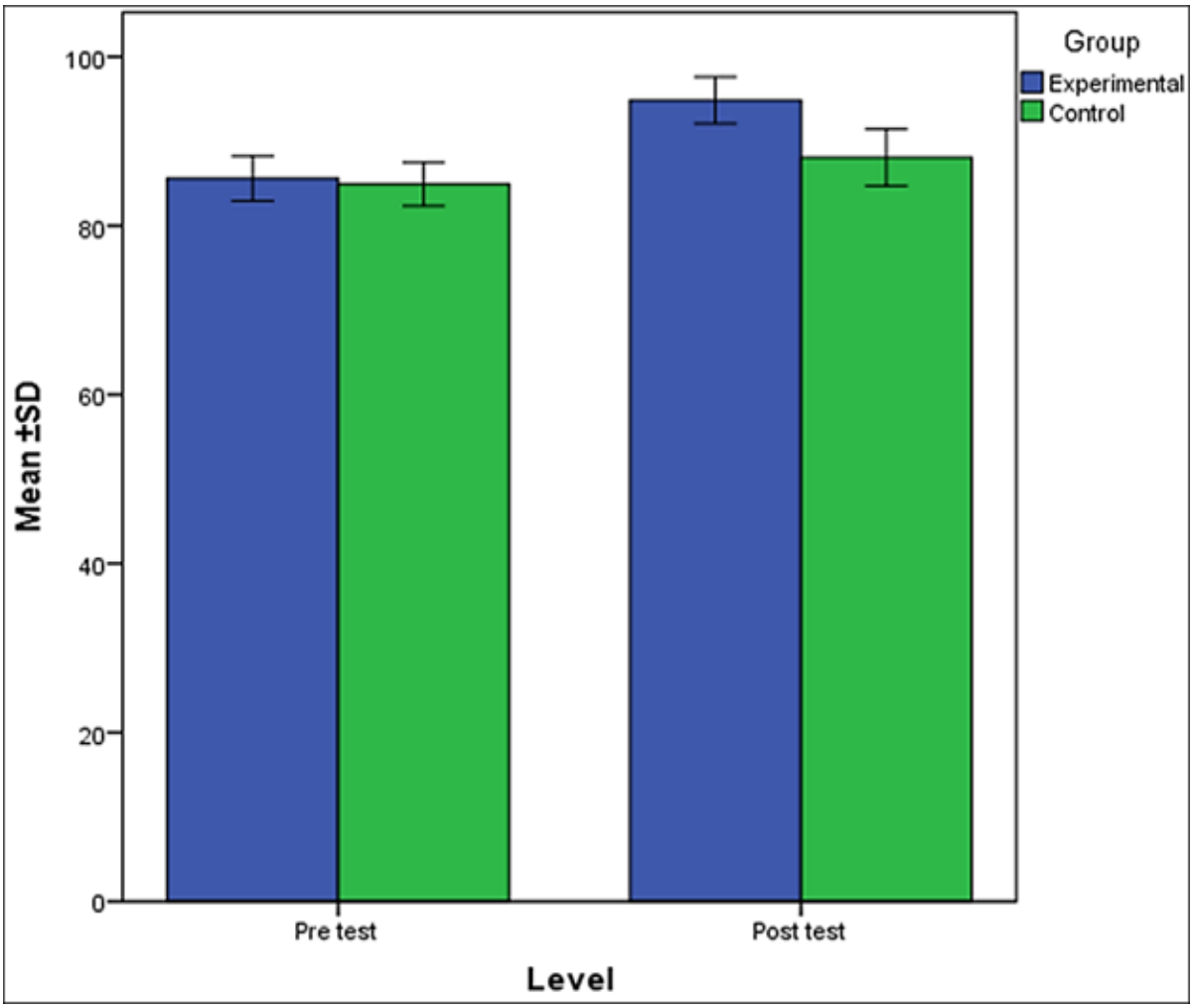


Graph 4: Mean and SD of pre and post-test ball throw velocity of cricket players in control group

Table 5: Comparison of pre and post-test outcome measures of cricket player sin between the groups

Sr. No.	Outcome measures	Pre test		Post test	
		Experimental	Control	Experimental	Control
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1.	Ball throw velocity (Kph)	85.60±2.68	84.92±2.58	94.84 ± 2.76	88.08 ± 3.36
Between group comparisons: Unpaired T-Test		Ball throw velocity (Kph): T=0.917, *p*>0.05, NS		Ball throw velocity (Kph): T=7.761, *p*<0.05, S	

S-denotes significant (*p*<0.05); NS-not significant (p>0.05).



Graph 5: Mean and SD of pre and post-test ball throw velocity of cricket players in between the group

Discussion

The purpose of this study was to know the effectiveness of core strengthening exercises on throw velocity of cricket players. In the present study an experimental study design of 50 subjects, cricket players in between the age of 15-20 years including both male and female were randomized into two groups: Group A (N=25) and Group B (N=25). Subjects in the Group A receives core strengthening exercises protocol with their daily workout for the three days per week for six weeks and subjects in the Group B received only daily workout protocol for three days per week for six weeks. Subjects were assessed pre and post intervention for ball throw velocity using the standardized formula.

It is found that, both the interventions in experimental (Group A) and control (Group B) were found to be individually effective in improving ball throw velocity of cricket players. But, while compared the post-test outcomes in between the groups, the intervention of core strengthening exercises in experimental group was found to be better on improving the ball throw velocity of cricket players than the cricket players treated with daily workout in control group.

Significant pre and post intervention throw velocity was noted in both groups over session of 3 days per week for 6 weeks.

In Group A, with Core Strengthening Exercises there exist a significant difference which was seen on comparing the pre session and post session values between the groups, which suggests that Core Strengthening Exercises are effective on ball throw velocity.

The preliminary study carried out by Abdul Hanan, Usman Asad *et al*. Effect of core muscle strengthening on throwing velocity in cricket players in Pakistan: a 6-week randomized controlled trial, a 6 weeks randomized controlled trial in which ninety-eight male cricket players participated and divided into strength training (interventional) and non-strength training (control group). Interventional group followed general core strengthening exercise protocol for six weeks for 3 days a week. Assessment of the players include core assessment test (back extension, supine forward flexion test, prone bridge test). Time and throwing velocity were noted by stop watch and radar gun in km/hr respectively at baseline and after 6 weeks of core training. Control group did not follow any exercise program but continued their usual cricket training. And they found the significant increase in throwing velocity and core endurance with six weeks general core strengthening in male cricket players [1].

Core musculature in our body is to maintain the stability of the body. It improves sports performance by enhancing the stiffness of the trunk which enables an individual to produce greater torque while executing anybody movement [5]. Core stability is the capability to control the position and motion of the trunk beyond the pelvis to confess optimum production, transfer and control of force and motion to the peripheral segment in combined athletic activities [23].

It was speculate that a strong core allows an individual the full transfer of forces created from the ground among the lower extremities, the torso and finally to the upper extremities and sometimes an appliance. So, it becomes very essential to encourage the core muscles of our body to get the maximum out of the performance [23]. Core strength training had an allowance on better posture, more control improved, more powerful performance, injury prevention and rehabilitation, increased protection and "bracing" for your back, a more reliable center of gravity, a more reliable platform for sports movements [23].

The research conducted by Rene Ferdinands on throwing velocity and accuracy in elite and sub-elite cricket players. They carried out the study in six different groups: elite senior males, elite under 19 junior males, elite under 17 junior males, elite senior females, elite under 19 junior females, and sub elite senior males. They found that sex, training experience, and training volume may contribute to throwing performance in cricket players [4].

Pooja Chugh Anand conducted a research on the relationship of core stability with bowling speed in male cricketer medium and medium fast bowlers, they measured bowling speed with radar speed gun and core stability was measured by plank test .They found that participants with well-developed core stability bowled significantly faster than the subjects with poorly developed core stability [11].

Throwing depends on overhead baseball pitching, throwing performance is a consolidation of both throwing speed and accuracy [19, 20]. Developing muscle strength and power of the upper and lower limbs had been found to be efficient in increasing throwing performance in sports such as baseball, handball and others [20, 85].

Specifically, cricketers have less elbow flexion during the stride phase of throwing resulting in a lower vertical release direction of the ball [19]. Pre-delivery stride splits the run-up from the delivery stride and begins, for a right-handed bowler, with a leap of the left foot and is done as the bowler lands on the right or back foot.

During this stride, with the shoulders facing down the wicket, the right foot passes in front of the left with the right foot turning to land parallel to the bowling line [22]. Delivery stride is contemplate the most technical stage of the bowling action, the delivery stride was be contour according to three key events:- the back foot strike, front foot strike and ball release [22].

As the delivery stride derives, the front foot strikes the ground. That's the front foot strike. The action of the bowling arm to circumduction of the upper arm around the gleno-humeral joint and the extension and flexion of the wrist and finger joints is known as ball release [22].

The biomechanics of men's cricket had been executed on the technique of fast or fast-medium bowling, the components are inveigled by players physiology such as muscle strength, throwing technique or biomechanics [20, 21].

In fact that experimental group showed a significant improvement in bowling after core stability protocol.

In pre-test, the ball throw velocity was ranging within 82-90 with mean and SD of 85.60±2.68. But in post-test, it was found to be increased to the range 90-99 with mean and SD of 94.84 ± 2.76. It evidence the there is a significant increase in ball throw velocity among cricket players treated with core strengthening exercise in experimental group (Group A), (Table no. 3).

Regarding outcome measures in pre-test, the ball throw velocity was ranging within 82-90 with mean and SD of 84.92±2.58. But in post-test, it was found to be increased to the range 84-98 with mean and SD of 88.08 ± 3.36. The parametric test for comparison of dependent outcomes, the paired t-test was carried out and it was found to be significant (p<0.001). (Table. no 4)

It evidence the there is a significant increase in ball throw velocity among cricket players treated with core strengthening exercise in experimental group (Group A).

In group B, with daily workout protocol exist a significant difference on comparing pre and post session but not as experimental group.

Tracy Morgan Handzel conducted a review on core training for improved performance. She explained that core training has penetrated a variety of fitness and performance related fields. Health clubs offer core training group exercise classes. Physical therapists prescribe core training programs for rehabilitation. Personal trainers incorporate core training. Also, the armed forces have included core training into their regimes. So, she stated that core training is not a fleeting trend and should not be ignored [30, 90].

Shibili Nuhmani conducted the study on "Efficacy of dynamic Swiss ball training in improving the core stability of collegiate athletes. The study was carried out among 67 athletes dividing them into two groups. The six weeks study was done. They found relatively high improvement in core stability parameters after Swiss ball training than the traditional floor exercises [35].

D Martinez-Garcia conducted the study on strength training for throwing velocity enhancement in overhead throw: A systematic review and meta-analysis. Their purpose of the study was to assess the effect of resistance training in enhancing throwing velocity in athletes and to investigate the relationship between age or gender in this effect. They found that throwing velocity enhancement after resistance training was greater for women than for men, and for adult's more than underage subjects [42].

In present study, in pre-test, the ball throw velocity was ranging within 82-90 with mean and SD of 84.92±2.58 (control group) and 85.60±2.68 (experimental group). But in post-test, it was found to be increased to the range 90-99 with mean and SD of 88.08 ± 3.36 (control group) and 94.84 ± 2.76 (experimental group). The parametric test for comparison of dependent outcomes, the paired t-test was carried out and it was found to be significant (p<0.001). (Table No 5).

So, comparison of pre and post-test outcome measures of subjects in between both the groups mentioned in the (Table 5) stated that both the interventions in Group A and Group B were found to be individually effective in improving ball throw velocity of cricket players. But, while compared the post-test outcomes in between the groups, the intervention of core strengthening exercises in experimental group was found to be better on improving the ball throw velocity of cricket players than the cricket players treated with daily workout in control group.

Conclusion

The present study concludes that both the interventions in experimental and control group were found to be individually effective in improving ball throw velocity of cricket players.

But, while compared the post-test outcomes in between the groups, the intervention of core strengthening exercises in experimental group was found to better on improving the ball throw velocity of cricket players than the cricket players treated with daily workout in control group.

Limitaions of study

- Male and female subjects are taken together.
- There is lack of control group. Thus, results cannot be generalized to individual age.
- Small Sample Size. And fixed population.
- Single school of thought was used.
- Findings are based on only the standardized formula of speed.
- Subjects with small range group between 15-20 years of age were considered for study. There is limited evidence exploring effect of core strengthening exercises on throw velocity in cricket players.

Recommendation for future research

- Further study can be done on large number of groups.
- Further study is needed to measure the effect of these techniques on other outcome measures.
- Multimodal approach could have been used.
- Further study is needed to compare the effect of other techniques with core strengthening exercises.
- Further study can be done by including more number of core strengthening exercises.
- Further study can be done separately in male and female candidate.
- Effect of core strengthening exercises on throw velocity can be compare separately among male and female individuals.

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