



Effects of Core Stability Training on Throwing Velocity and Accuracy of Under-19 Professional Cricketers of Sikkim

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KEYWORDS

Speed accuracy trade off, electromyograph, Flexor Endurance test, Throwing accuracy test, Side-bridge test, Sorensen test.

ABSTRACT:

Introduction:

Cricket is an internationally recognised and one of the most popular games played in India by both males and females, it is a game that utilizes a bat-and-ball and is played on a 22-yard pitch between two teams of eleven players in each team. It is played with three primary skills viz. batting, bowling, and fielding.

The important facet to consider in cricket is throwing, which is an important aspect of fielding in cricket as the fielders from the bowling side commonly employ the overhead throw to deliver the ball back to the wicket keeper, bowler, or a direct contact of the ball on the stumps or a run out after it has been hit by the batsmen. It has been reported that a proximal-to-distal sequence of muscle activation is an important factor for achieving high ball speed in throwing. (3,4) During overhead throwing, (left external oblique, right external oblique, rectus abdominis) following core muscles are activated.

In addition to the core muscles, the serratus anterior muscle (sixth rib) is the first muscle to be activated. This is followed by the activation of the serratus anterior muscle (eighth rib), which led to the shoulder horizontal flexor muscles mainly pectoralis and anterior deltoid, which was followed by a further sequence of muscle activation from the shoulder horizontal flexor muscles to the elbow extensor, i.e., by activation of flexor carpi ulnaris, pronator teres & triceps brachii muscles. (3)

Studies have found that, a deficient core may increase the risk of injuries in the upper extremity due to overload in the shoulder joint. (7) Livia Silveira et al, 2018 found that impaired trunk muscles performance may affects the activation of the serratus anterior, resulting in decrease scapular upward rotation and posterior tilt, which may contribute to development of pain and shoulder injury. (8) The prevalence rates of injuries sustained in the shoulder during a single season was found to be 23% out of which the fielders consisted of 63% and the bowlers attributed to 35% of negative performance impact in their game. (5,6)

As cricket is played with three skills, a player needs a combination of balance, core strength and agility. (12) Core stability is the basis of strong motions and control. It also plays a crucial role in the stabilisation and force production of the body's central core, which is essential for the accomplishment of many athletic endeavours. (12) Additionally, the core is essential to nearly all



kinetic chains in sports activities and offers local strength and balance. All kinetic chains of the upper and lower limbs' function will be maximized by control of core strength, balance, and motion.

Recently, core stability training has been suggested to be an effective tool for improving throwing velocity in handball players which include both male and female players. (14,15) Although training programs that incorporate core stability training under unstable conditions have been shown to increase core muscle activation, Jose M olive Lozano et al.,2020 studied EMG activity of six core muscles during core physical fitness, the study concluded that greatest activity in all six core muscles was found in free-weight exercise rather than other core exercise (traditional, stability, ball/device stability exercise). (16)

James L Nuzzo et al.,2008 studied trunk muscle activity during stability ball and free weight exercises, study concluded that muscle activity of the back extensors was significantly greater in free weight exercise (like squats, deadlifts) when compared to stability ball exercises designed to activate the same muscles.(17) Hence, the purpose of this study is to determine the effects of core stability training mainly using free weight exercise on throwing velocity and accuracy in U-19 professional cricketer in Sikkim. It is hypothesized that free weight core stability training is superior to any other forms of core stability exercise as it showed greater activation of core muscles in EMG hence, improvement of core muscles is more which will impart improvement in throwing velocity and accuracy while performing overhead throws in cricket.

Methodology:

A Randomized Controlled Trial was conducted in two playgrounds of Sikkim and an indoor stadium. (Tathengchen, Tadong college ground, GMC Indoor Stadium).

Players from both genders, who were aged below 19 years and have been playing for Sikkim for at least one year, and who have not sustained an injury a month prior to the conduction of the study were included as participants for this study. Duration was One year i.e., December 2022 to May 2023. Subjects were selected by Computer generated random sampling.

Result:

Interaction effects of type of training vs time points were computed for outcome measures and is presented in table 8. Significance of change or the difference between the intervention group and control group at baseline, fourth-week, eight-week, twelve-week at 95% Confidence Interval was computed for both U-14 and U-19 age groups.

From baseline to twelve-week we could see the interaction effects for both U-14 (control/experimental) and U-19 (control/experimental) groups, it can be concluded that there is significant difference measured in throwing velocity and accuracy as well in core endurance between the group at different set of time.

Conclusion: Twelve weeks of core stability training showed significant improvement in throwing velocity and accuracy among under-19 professional cricketers of Sikkim. In addition, there is significant improvement in core endurance with twelve weeks of core stability training. Core stability training program including free weight exercises may paly vital role in improving throwing velocity and throwing accuracy which ultimately improves game performance in professional Cricket players.



INTRODUCTION

Cricket is an internationally recognised and one of the most popular games played in India by both males and females, it is a game that utilizes a bat-and-ball and is played on a 22-yard pitch between two teams of eleven players in each team. It is played with three primary skills viz. batting, bowling, and fielding. ⁽¹⁾

It has been reported that a proximal-to-distal sequence of muscle activation is an important factor for achieving high ball speed in throwing. ^(3,4) During overhead throwing, (left external oblique, right external oblique, rectus abdominis) following core muscles are activated.

The first abdominal muscle to engage is the left external oblique muscle, with most of this activity occurring right before the foot strikes and preventing the upper trunk from rotating with the pelvis. The right external oblique begins to contract nearly immediately after the foot strikes; it does so concurrently with the serratus anterior muscle (eight ribs) and is followed by the serratus anterior muscle (sixth rib). Just prior to the release point (accelerating, decelerating phase), the rectus abdominis is contracted.

In addition to the core muscles, the serratus anterior muscle (sixth rib) is the first muscle to be activated. This is followed by the activation of the serratus anterior muscle (eighth rib), which led to the shoulder horizontal flexor muscles mainly pectoralis and anterior deltoid, which was followed by a further sequence of muscle activation from the shoulder horizontal flexor muscles to the elbow extensor, i.e., by activation of flexor carpi ulnaris, pronator teres & triceps brachii muscles. ⁽³⁾

According to Sakurai and Ootsuka et al. (2000), timing of finger extension is more crucial for precise overhead throwing than wrist muscles, which suggests that distal muscles may be more essential for accuracy than speed generation.

Studies have found that, a deficient core may increase the risk of injuries in the upper extremity due to overload in the shoulder joint. ⁽⁷⁾ Livia Silveira et al, 2018 found that impaired trunk muscles performance may affects the activation of the serratus anterior, resulting in decrease scapular upward rotation and posterior tilt, which may contribute to development of

pain and shoulder injury. ⁽⁸⁾ The prevalence rates of injuries sustained in the shoulder during a single season was found to be 23% out of which the fielders consisted of 63% and the bowlers attributed to 35% of negative performance impact in their game. ^(5,6)

When a kinetic chain functions, muscle activation is based on a pre-programmed sequence that creates proximal stability for distal motion. Rotation of the trunk generates the greatest force needed to internally rotate the shoulder and rotate the arm. The interactive wrist movement caused by shoulder movement is related to the accuracy of ball throwing. ⁽³⁾ The activation of the core is crucial for producing proximal to distal development of force and motion. The trunk plays a key role in creating forward momentum when throwing, and rather than the rotator cuff, the periscapular and trunk muscles are responsible for about 85% of the muscle activity needed to slow the forward-moving arm. ^(3,4)

Recently, core stability training has been suggested to be an effective tool for improving throwing velocity in handball players which include both male and female players. ^(14,15) Although training programs that incorporate core stability training under unstable conditions have been shown to increase core muscle activation, Jose M olive Lozano et al.,2020 studied EMG activity of six core muscles during core physical fitness, the study concluded that greatest activity in all six core muscles was found in free-weight exercise rather than other core exercise (traditional, stability, ball/device stability exercise). ⁽¹⁶⁾

James L Nuzzo et al.,2008 studied trunk muscle activity during stability ball and free weight exercises, study concluded that muscle activity of the back extensors was significantly greater in free weight exercise (like squats, deadlifts) when compared to stability ball exercises designed to activate the same muscles. ⁽¹⁷⁾ Hence, the purpose of this study is to determine the effects of core stability training mainly using free weight exercise on throwing velocity and accuracy in U-19 professional cricketer in Sikkim. It is hypothesized that free weight core stability training is superior to any other forms of core stability exercise as it showed greater activation of core muscles in EMG hence, improvement of core muscles is more which will



impart improvement in throwing velocity and accuracy while performing overhead throws in cricket.

METHODOLOGY

STUDY DESIGN

A Randomized Controlled Trial

STUDY SUBJECTS

Registered U-19 Professional Cricketers of Sikkim.

STUDY DURATION

One year i.e., December 2022 to May 2023

Investigator: Student pursuing Master's in Physiotherapy in Orthopedic-Manual Therapy Primary Investigator: screened and gave intervention to both groups.

Secondary Investigator: Took the Outcome measures (Modified Schober Test, Active Knee Extension, and ODI) (MPT student).

OUTCOME MESURES

Maximum throwing velocity

The purpose of this test was to evaluate the maximum throwing velocity. Participants were instructed to perform a maximal throw with a cricket ball from behind a marked line at 20.14 metres while wearing wrist-mounted inertial sensors tied to their dominant arms. (19)

Throwing Accuracy test

Test throws were performed from the same distance of 20.14 metres. Target consisted of one stump which were placed in the ground and was surrounded by five marked zones with each cone placed 14 cm apart from each other. (19)

Mc Gill Endurance test

The purpose of this test was to evaluate the trunk muscle endurance. It includes three isometric tests which are Flexor endurance test, Sorensen test and Side-bridge test.

(ICC=0.96) A Walldhelm et al, 2012. (23)

Inertial sensor

This device, which was attached to the participant's dominant arm's wrist, was used to measure the participant's maximum throwing velocity.

(ICC=0.93) Vanina Costa et al, 2020. (24)



Figure 1. Photo of the Outcome Measures





Barbell with weights

Stool-chair

Belts

Figure 2- Instruments used in the study

Procedure for Maximum throwing velocity:

Participants were provided standard warm-up exercises, which included 5–10 minutes of moderate intensity running, 5–10 minutes stretching of main muscle group stretches, and then 5 minutes of throwing. The participant's dominant arm is tied to a wrist-mounted inertial sensor. Participants were told to throw the cricket ball (weight- 151g and circumference- 22.5cm) as far as possible from behind a designated line, which was set 20.14 metres from the target, which is equivalent to the length of a cricket pitch without any targets in place. "Throw as hard as you can," was the instruction given to the participants. Participants were allowed make four throws with the greatest amount of force while maintaining one forward step and keeping their front foot in place until the ball was released. The highest measurement value was recorded as the participant's peak maximal throwing velocity, and the average of the four throws were recorded as the mean maximal throwing velocity.



Figure 3- Participant performing overhead throwing for maximum throwing velocity test.



Figure 4 - Participant's dominant arm was tied with inertial sensor.



Figure 5- Data was recorded through sensor.

Procedure for Throwing accuracy test:

1. Participant were allowed to perform cricket specific throwing accuracy test. Throws was performed from same distance as they performed for maximum throwing velocity. Target consist of one cricket stump and was placed in the ground, which is surrounded by five marked zones, with each cone placed in respective zones which was 14 cm apart from each other. Participant were allowed to perform 10 trials of throws at self-selected pace aiming towards the target placed and score was determined.
2. Scores were attributed as follows: Direct hit on stump= 0-point, Zone 1= 1 point, Zone 2= 2 points, Zone 3= 3 points, Zone 4= 4points, outside zone 4 = 5 points.



Figure 4 - Throwing Accuracy Test

Procedure for Mc Gill endurance test:

Participants were tested with three different isometric tests for trunk muscle endurance, which includes, Sorensen test, Flexor endurance test, Side-bridge test. Each test was performed in a set of two trials with five-minute rest intervals between trials.

- **For Sorensen test:**

Each participant was placed prone, with the tops of their iliac crests resting on the table's upper edge, and their ankle, knee, and pelvis were each secured by two straps. The surface of the test bed is roughly 75 cm above the ground. Before and after the test, a chair at the same height as the bed is provided for support. The upper body was raised off the supporting surface and held in a horizontal torso position for as long as possible at the beginning of the test while the upper limbs were held across the chest with the hands resting on the opposing shoulders. When the participant could no longer maintain a horizontal position, the test was over.

- **For Flexor endurance test:**

Free Weight Exercise Protocol (Experimental group)

Table 1- Free weight exercises			
EXERCISE	CORE MUSCLE TARGETED	SETS	REPETITION

Each participant was seated upright with their backs resting against a back support that was angled at a 60-degree angle from the floor. The feet were strapped to the bed, and the knees and hips were bent 90 degrees. Crossed over the chest are the arms. The support was first pulled back 10 cm, and the participant was instructed to maintain their position as best they could. When the participant was unable to maintain the position, the test was over.

- **For Side bridge test:**

Each subject was lying on their side. The higher foot was positioned in front of the lower foot for support when the legs were extended. Participants used their feet and elbows to support themselves. Participants were instructed to raise their hip off the ground just utilising their lower elbow and feet as support. With the hand resting on the opposing shoulder, the uninvolved arm was crossed across the chest. When the hip reaches the bed again, the test was over.



Figure 5- Participants performing Sorensen test



Figure 6 Participants performing Flexor endurance test



Figure 7 Participants performing Side-bridge test



Bulgarian squat	External oblique	3	10
Dumbbell press/ Kettlebell swing	Internal oblique	3	10
Hip thrust/ Deadlift	Erector spinae	3	10
Bent over row	Lumbar multifidus	3	10
Back squat	Rectus abdominis	3	10

1. The Bulgarian Squat:

Participants stood with their feet flat on the ground, one front leg extended, and the other put on the back of a bench. About 80% of the leg's length separates the front leg from the bench. The barbell was then positioned behind its neck. The subject was told to squat with the front leg to lessen the weight.

2. The Dumbbell press:

Participant was standing /sitting with their feet shoulder-width apart and their knees bent to 90 degrees (seated dumbbell press). The dumbbells should be held by the participant with the thumb side facing the participant's ears. He or she was told to press the weights forward straight while keeping the spine in neutral position.

3. The Kettlebell swing:

Participant was holding a kettlebell in each hand while squatting. The participant is asked to quickly raise the kettlebell to chest level by extending the knees and hips.

1. Hip thrust:

Participant was seated on the floor with their knees bent at a 90-degree angle and their upper back resting on a bench. The spine is kept in a neutral position while the barbell is positioned over the pelvis. The subject was given instructions to raise the barbell using a hip thrust motion.

2. Deadlift:

Participant was in a standing position with feet shoulder-wide apart, they are instructed to lower the body to lift the barbell until the hip is fully extended while maintaining spine in neutral position.

3. Bent over row:

Participant was in a standing position with feet shoulder-width apart, the knees are flexed to lean the trunk forward from the waist, the spine will remain in neutral position. The hands hold the bar slightly wider than shoulder-width apart with elbows extended. The participants were asked to row the weight up until it touches the upper part of the abdomen.

4. Back Squat

Participant was in standing position with their knees fully extended and their lower back swaying naturally. Behind the neck, the barbell was positioned. The subject was required to hold the complete squat position while lowering the load in a controlled but self-paced way.

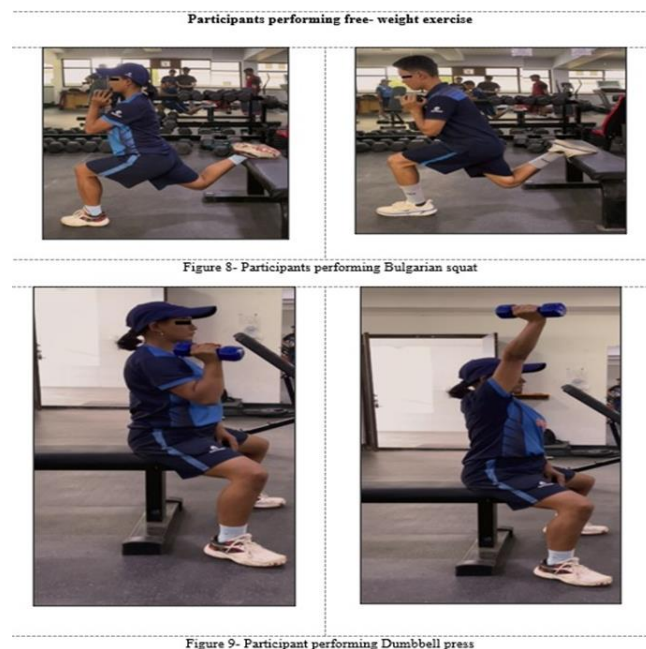




Figure 10- Participant performing Kettlebell swing



Figure 12- Participant performing Deadlift



Figure 11- Participant performing Hip thrust



Figure 13- Participant performing Bent over row



Figure 14- Participant performing Back squat

Regular Core Stability Training (Control group)

Table 2- Regular Core stability training			
EXERCISE	CORE MUSCLES TARGETED	SETS	REPETITION
Curls up/ crunches	Rectus abdominis	3	10



	Internal oblique		
Double leg stretch	Rectus abdominis External oblique	3	10
Bilateral leg raises	Transverse abdominis	3	10
Bird-dog	Rectus abdominis Erector spinae External oblique	3	10

1. Curl up/ Crunches:

Participant was lying on the floor with their feet hip-width apart and their knees bent. Hands were used to raise the upper body, which was then brought back to the starting position.



Figure 15- Participant performing Curl-up/ Crunches

2. Double leg stretch:

Participant was on the floor with their knees and hips bent in towards their stomach and their hands resting on their patellas. The head, shoulders, arms, and legs are kept off the supporting base as the upper and lower limbs are extended simultaneously.



Figure 16- Participant performing Double leg stretch

3. Bilateral leg raise:

Participant was lying on the floor with their palms facing down. The participant kept their knees extended and elevated both legs by flexing their hips.



Figure 17- Participant performing Bilateral leg raises

4. Bird-dog:

Participant was lying on his or her back with the hands and knees beneath the shoulders. The participant elevated the left leg with hip extension and the right arm with a 180-degree shoulder flexion. As a result, when the left arm is raised, the right leg extends at the hip.

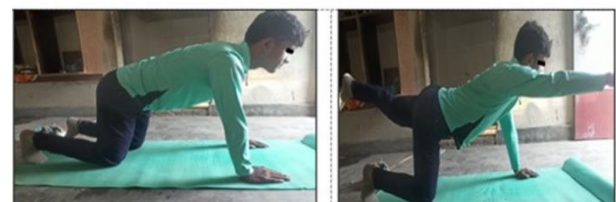


Figure 18- Participant performing Bird-dog

Results

A total of eighty-nine participants were screened for inclusion and exclusion criteria during the period of December 2022 to May 2023. Seventy-nine participants who met the inclusion criteria were included in the study



VARIABLES	EXPERIMENTAL (n=38)	CONTROL (n=38)
Age (Mean \pm SD)	15.54 \pm 3.034	14.31 \pm 2.774
Male: Female (N, %)	(22/17), (56%/44%)	(24/15), (21%/61%)
Dominant Arm (N, %)		
Right	32(82%)	30(77%)
Left	07(18%)	09(23%)
Profession (N, %)		
Batsmen	16(41%)	14(36%)
Bowler	15(38%)	14(36%)
All-rounder	8(21%)	11(28%)

Comparison of group outcomes

Measures	Control (n=39)		Experimental (n=39)		p-value	
	U-14	U-19	U-14	U-19	U-14	U-19
Throwing accuracy test	2.35 \pm 4.372	4.09 \pm 5.032	4.00 \pm 5.071	8.33 \pm 7.614	.332	.033
Throwing velocity	106.59 \pm 10.542	113.82 \pm 9.440	116.33 \pm 27.012	131.33 \pm 20.361	.179	.001**
Flexor endurance test	20.853 \pm 7.236	30.250 \pm 4.4367	27.533 \pm 8.911	36.104 \pm 4.6085	.026	.002**
Sorensen test	22.294 \pm 7.541	25.318 \pm 6.739	22.294 \pm 7.541	32.792 \pm 25.318	.069	.003**
Side-bridge test	27.476 \pm 10.135	31.636 \pm 7.907	32.186 \pm 7.487	35.663 \pm 4.045	.149	.332



Table 5 – Summary of U-14 group by time data for outcome measures which showed significant interaction effect.

VARIABLES	TIME	GROUP	MEAN± SD	CI 95%
Throwing accuracy test	Baseline	Experimental	4.00±5.071	1.516-6.484
		Control	2.35±4.372	.016-4.687
	4 th Weeks	Experimental	9.33±7.037	6.219-12.447
		Control	2.94±4.697	.019-5.866
	8 th Weeks	Experimental	25.33±6.399	22.069-28.598
		Control	8.82±6.002	5.757-11.890
12 th Weeks	Experimental	36.67±8.997	32.232-41.101	
	Control	16.47±7.859	12.305-20.636	
Throwing velocity	Baseline	Experimental	116.33±27.012	105.790-126.877
		Control	106.59±10.542	96.684-116.492
	4 th Weeks	Experimental	208.07±61.244	185.222-230.911
		Control	138.06±15.397	116.600-159.517
	8 th Weeks	Experimental	311.67±106.603	271.295-352.038
		Control	183.82±32.354	145.901-221.746
	12 th Weeks	Experimental	391.47±131.939	342.523-440.410
		Control	212.65±30.348	166.673-258.621

Table 6- Summary of U-14 group by time data for outcome measures which showed significant interaction effect

VARIABLES	TIME	GROUP	MEAN± SD	CI 95%
Flexor Endurance test	Baseline	Experimental	27.533±8.911	23.282-31.784
		Control	20.853±7.236	16.860-24.846
	4 th Week	Experimental	38.800±11.575	33.955-43.645
		Control	27.088±6.4061	22.537-31.639
	8 th Week	Experimental	51.433±13.079	46.190-56.677
		Control	34.618±5.977	29.692-39.543
12 th Week	Experimental	63.733±15.831	57.280-70.186	
	Control	41.147±7.841	35.085-47.209	
Sorensen test	Baseline	Experimental	22.294±7.541	23.313-30.953
		Control	22.294±7.541	18.706-25.882
	4 th Week	Experimental	40.667±15.317	34.666-46.668
		Control	28.265±6.126	22.628-33.902
	8 th Week	Experimental	54.033±15.528	48.026-60.041
		Control	35.912±5.690	30.269-41.555
	12 th Week	Experimental	61.633±13.984	55.788-67.478
		Control	41.618±7.698	36.127-47.108



	Baseline	Experimental	32.186±7.487	27.442-36.931
Side-bridge test		Control	27.476±10.135	23.014-31.927
	4 th Week	Experimental	45.233±13.474	39.518-50.949
		Control	32.088±7.836	26.719-37.457
	8 th Week	Experimental	60.467±16.125	54.009-66.924
		Control	39.588±7.325	33.523-45.654
	12 th Week	Experimental	71.700±14.873	65.406-77.994
		Control	49.912±8.579	43.999-55.824

Table 7 – Summary table of effects in outcome measures

MEASURE	FOLLOW-UP				ANALYSIS	EFFECT	F		P		η ²	
	CONTROL N=39		EXPERIMENTAL N=39				U-14	U-19	U-14	U-19	U14	U-19
	U-14	U-19	U-14	U-19								
THROWING ACCURACY TEST	16.47±7.859	17.73±6.119	36.67±8.997	43.33±8.681	GLM-RM ANOVA	Group x time	29.41	38.62	0.00*	0.00*	.495	.467
THROWING VELOCITY	212.65±30.348	417.20±190.340	391.47±131.939	587.08±81.875	GLM-RM ANOVA	Group x time	25.29	203.07	0.00*	0.00*	.457	.822
FLEXOR ENDURANCE TEST	41.147±7.841	46.023±6.726	63.733±15.831	70.667±10.118	GLM-RM ANOVA	Group x time	18.75	31.13	0.00*	0.00*	.385	.414
SORENSEN TEST	41.618±7.698	44.273±5.936	61.633±13.984	70.479±9.7148	GLM-RM ANOVA	Group x time	17.52	31.65	0.00*	0.00*	.369	.418
SIDE-BRIDGE TEST	49.912±8.579	54.341±6.746	71.700±14.873	81.604±15.826	GLM-RM ANOVA	Group x time	15.44	29.97	0.00*	0.00*	.340	.405

Note: all values in mean and standard deviation unless stated other wise

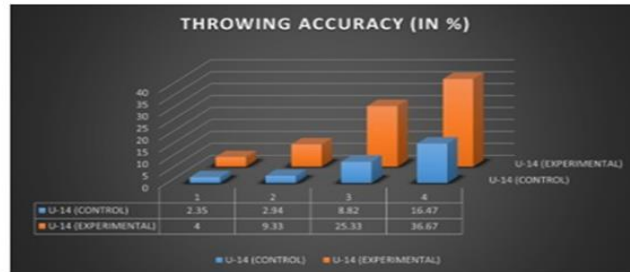


Figure 19– Mean Throwing accuracy (in %) scores at baseline, 4th week, 8th week, 12th week for U-14 (control/experimental group)

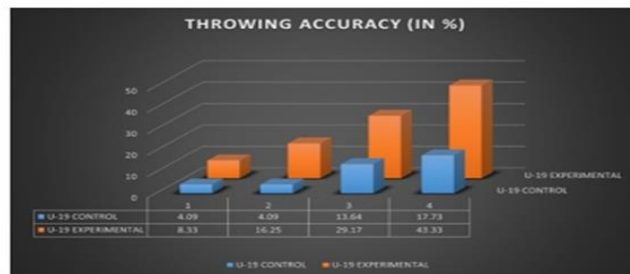


Figure 20– Mean Throwing accuracy (in %) scores at baseline, 4th week, 8th week, 12th week for U-19 (control/experimental group)

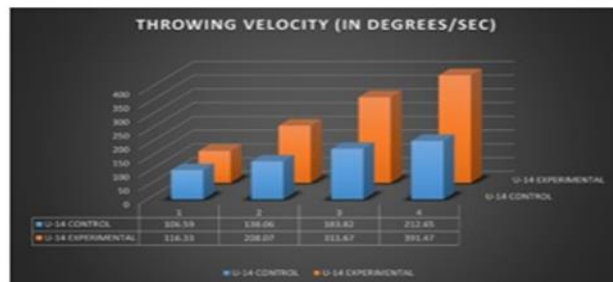


Figure 21– Mean Throwing velocity (in degrees/sec) scores at baseline, 4th week, 8th week, 12th week for U-14 (control/experimental group)

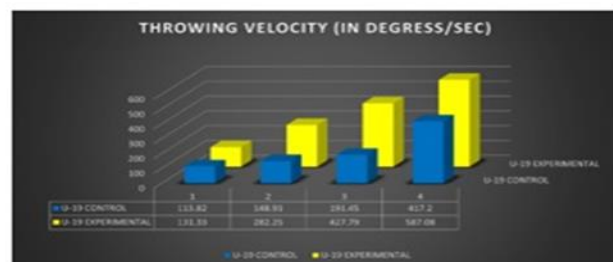


Figure 22– Mean Throwing velocity (in degrees/sec) scores at baseline, 4th week, 8th week, 12th week for U-19 (control/experimental group)



Figure 23– Mean Side-bridge test (in seconds) scores at baseline, 4th week, 8th week, 12th week for U-14 (control/experimental group)



Figure 24– Mean Side-bridge test (in seconds) scores at baseline, 4th week, 8th week, 12th week for U-19 (control/experimental group)

Discussion

In this study, both the experimental and control group consisted of both under-19 (age included of 15-19 years) and under-14 (age included of 12-14 years) players, the results of which were concurrent in the experimental group that had statistically significant improvements in both throwing velocity and accuracy, with an increase in their average core endurance.

In this study, both the experimental and control group consisted of both under-19 (age included of 15-19 years) and under-14 (age included of 12-14 years) players, the results of which were concurrent in the experimental group that had statistically significant improvements in both throwing velocity and accuracy, with an increase in their average core endurance.

Based on our hypothesis, that an increase in the level of core strength results in improvement in the player's kinetic movement like overhead throwing, several research have applied this hypothesis in different kinds of overhead dominant sports like baseball, handball, and

softball. The study conducted by Carmen Machado et al in 2017 showed that an increase in strength and stability of Lumbo-pelvic region which is an important determinant of core improvement in an overhead throwing velocity in handball players. ⁽¹⁴⁾

The result of present study suggests that there is increase in throwing velocity and accuracy in both under-19 and under-14 players of experimental group in twelve weeks of training, this can be attributed to an increase in strength of lumbo-pelvic region as a result of core stability training, which in turn leads to an improvement of kinetic chain movement, that progresses in proximal-distal direction as a result of increase in stability and greater transmission of force between the upper and lower extremities that is required for throwing action (Kibler et al, 2006). ⁽¹³⁾

A study done by Willson et al, in 2005 also concluded that decrease core stability may be an indicator to increase risk of injury. ⁽³²⁾ Chaudhari et al, (2014) investigated the relationship between core stability and



injuries in baseball players, the result highlighted those players with decrease core stability reported 60% of injuries in upper extremity, 14% of injuries in trunk and back. The result also confirms the conclusion reached in the study conducted by Pontillo et al, (2014) suggested that poor core stability should be considered as pre-indicator of upper extremities injuries in future. ⁽³³⁾

The result of the present study and of those seen above confirms the importance of core stability training in sports like cricket, and sports having similar background for overhead throwing capacity concluding strong evidence in the improvement in physical performance, such as throwing velocity and accuracy and reduced risk of injuries in the future associated with overhead movements. ⁽³⁴⁾

Conclusion

Twelve weeks of core stability training showed significant improvement in throwing velocity and accuracy among under-19 professional cricketers of Sikkim. In addition, there is significant improvement in core endurance with twelve weeks of core stability training. Core stability training program including free weight exercises may play vital role in improving throwing velocity and throwing accuracy which ultimately improves game performance in professional Cricket players.

References

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