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The Relationship of core Stability to Functional Movement Screening score and Bunkie's test in Young Male Competitive Athletes

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ABSTRACT: The core is a vital component of the human body. The core refers to a group of muscles that stabilise and control the spine and pelvis. It is usually divided into an upper core and a lower core. The proper functioning of the core is required for stabilising the spine and the other joints over which movement patterns occur. The core muscles are activated even before the movements happen in the limbs. Having good control over the core and training the core to improve the overall stability and smoothness of bodily movements have been studied often. Core training is a vital component of training an athlete. Core stability is assessed by the McGill test battery. The Functional Movement Screening (FMS), consisting of seven movement patterns, and the Bunkie Test, consisting of five components assessed bilaterally, are often used to predict injury risk in athletes. Encouraging participants to adhere to the study protocol and complete assessments or training interventions is key to obtaining accurate and reliable data. This study investigates the correlation of core stability to FMS and the bunkie test in order to establish an association between the core and the risk of injury in the athletic population.

Keyword: Core stability, Functional movement, Bunkie's test, Athletes.

INTRODUCTION

Sport is fascinating. Everyone, at some point in their lives, has played a sport or enjoyed watching a sport. In general, sportspeople are expected to be stronger and fitter than others and are often called athletes. Athlete is a word from ancient Greek that means "one who competes for a prize" and is related to the Greek words athlos and athlon, which both mean "reward." (The Athletes: The Real Story of the Ancient Olympic Games, Penn Museum, n.d.).

The core is a vital component not only for athletes, but for any human. The core acts as a base or platform over which the movements of the extremities are patched. The strength, stability, and effectiveness of the movements of the extremities depend on a stable core, where the movement is believed to be initiated. Having a strong core and training the core have been related to better movement control and coordination of the movements of the human body along with those of the extremities.

Those athletes who participate in track and field events train really hard to enhance their sporting performances. The demands of track and field athletes are high as they are required to optimise their performance through various parameters like strength, stability, coordination, movement control, efficiency of the movements in a smooth sequenced manner, utilising the appropriate energy source for the particular event, good technique, perfect biomechanically correct movement patterns, proper concentration, and mindful execution. Most of these factors that contribute to better performance are closely linked to correct movement patterns. Deviations detected in these factors could lead to injury risk and compromises in sporting performance.

Studies suggest that a weak core may contribute to the onset of sports-related injuries (Fredericson *et al*., 2000; Niemuth *et al*., 2005). Functional movement screening (FMS) (Cook, 2010; Cook *et al*., 2006) and the Bunkie test (Brumitt, 2011; van Pletzen *et al*., 2012; Maryam *et al*., 2015) have been used often for injury risk prediction. The core weakness has been related to injury risk, and injury risk can be predicted by the FMS and the Bunkie test.

Core stability exercises can be used as a valuable supplement to regular tennis training to improve fundamental movement patterns and core stability test results (Majewska *et al*., 2022). Core training is a new strength training method that optimises the transfer and control of motion and force to the terminal segment and increases stability and stiffness in the spine to reduce energy leaks (Luo *et al*., 2022). Core training has a positive effect on general athletic performance but not on sport-specific athletic performance. It is necessary to design core training programmes to improve sport-specific performance (Dong *et al*., 2023).

A weak core has been linked to poor movement patterns and injury risk, which results in poor performance in sports. The FMS has been established as a predictor of injury risk due to poor movement patterns. The Bunkie test has been established as a predictor of fascial integrity and core stability as well as an injury risk predictor.

In this study, an attempt is made to verify the correlation between core stability measured by the McGill core stability test and FMS score and bunkie test score to check if there is a relationship between core stability or core weakness and injury risk in healthy male competitive athletes who participate in track and field events. The correlation between FMS and the Bunkie test is also tested in this study.

MATERIAL AND METHODS

Twenty young male athletes aged between 20 and 25 years, who train and compete in track and field events at college level formed the participants of this study. It was ensured that the participants have been training for a minimum of one year and have participated in not less than two competitive events within the past year. They were free from any injury when the assessments were taken and at least for one month before the assessment. The athletes did not have any hospitalization in the past six months and were apparently healthy individuals without any musculoskeletal deformities that would alter their movement patterns. Those who had any competitions within a week of the assessment were excluded from the study. Only those who gave their voluntary consent for participation were included in the study.

This is a one-time observation study where each participant was assessed as follows:

Pre participation consent was obtained from each participant. The pre participation screening was done and physical activity readiness questionnaire (PAR-Q) was taken before the test observations.

Procedure:

The participants performed all the seven movement tests of FMS (Deep squat, hurdle step, inline lunge, shoulder mobility, active straight leg raise, trunk stability push up and rotary stability) but not necessarily in any particular order. Each movement was performed three times and the best of the three-movement pattern was recorded, as proposed by Gray Cook (Cook, 2010; Cook et al., 2006). Five of these tests (inline lunge, hurdle step, shoulder mobility, active SLR and rotary stability) were done bilaterally and the lower score (between the left and right side) was considered. A rest period of one minute was given between each movement pattern. The maximum score for each movement was 3 and the minimum was 0, making the maximum possible total score of 21 for the seven tests. The scores obtained were recorded.

The core stability was assessed using the McGill test battery (Waldhelm *et al*., 2012) which is more of a core stability test. In addition to this the double leg lowering test and the seated medicine ball throw (Harris et al., 2011) tests which are more dynamic tests were also performed.

The double leg lowering test (Rathod *et al*., 2021) (DLLT) was performed in supine lying. The participant crossed both his arms to touch the opposite shoulder and lifted both lower limbs to 90 degrees of hip flexion with the knees extended as much as possible. An inflated pressure cuff (upto 40 mm hg) was placed under the sacrum and the participant was instructed to draw his umbilicus towards the lumbar spine and do posterior pelvic tilting to maintain the pressure in the cuff. The participant was required to lower both his lower extremities held together from 90 degrees of hip flexion with fully extended knee to as low as possible without the pressure in the cuff reducing below 40 mm hg. The test was stopped when the participant was not able to maintain the pressure in the cuff over 40 mm hg. Three chances were given to raise the leg and hold the pressure above 40 mm hg, whenever the pressure reduced in the cuff. The lowest possible angle maintaining the 40mmhg pressure in the cuff was recorded as DLLT score in degrees. The lower the angle, the better the dynamic core stability. This score was more of an indicator of lower core which translates to stability of the lower extremity during movements.

The next test was the seated medicine ball throw test. The participant was seated on a backless stool. He was required to throw a medicine ball as far as possible from the seated position over his head and in a backward direction without lifting his legs off the floor. A 3-kg medicine ball was used. The best of three repetitions was recorded. This gave a score in metres closest to one decimal (10 cm). This score was more of an indicator of the upper core, which translates into stability and strength for the upper extremities during movements.

The core stability was assessed next using the McGill core stability tests (flexion torso, extension torso, left lateral bridge, and right lateral bridge). Each test position was demonstrated, and the participant was required to hold these test positions for as long as possible without any deviations from the test position. The test was stopped when the participant was no longer able to hold on to the position or deviated from the position, and the time was recorded in seconds. A minimum of five minutes and a maximum of 15 minutes of rest were allowed between the test positions as per the participants readiness to take the next test position. The total time (sum of all the four individual test scores) was also recorded. It was ensured that the total time taken for one participant to record the FMS, DLLT, seated medicine ball throw test, and the McGill test battery was within two hours.

The bunkie test was administered the next day (after 24 hours of rest). The bunkie test consists of five tests (anterior power line (APL), posterior power line (PPL), posterior stabilising line (PSL), medial stabilising line (MSL), and lateral stabilising line (LSL)) done bilaterally for a total of ten scores recorded in seconds. The test positions were demonstrated to the participants before they assumed them. Any deviation from the test position or inability to hold the test position would terminate the test. The test positions were held on the left and right sides separately for as long as possible, and the scores recorded in seconds. A minimum of five minutes and a maximum of 10 minutes of rest were allowed between the test positions as per the participants readiness to take the next test position. At any cost, it was ensured that the total bunkie test was wrapped up within two hours for one participant. The total bunkie score of all ten test positions was also recorded in seconds. Ten of the participants followed this order of testing, and the day pattern was reversed for the next ten participants to counter any order effect.

RESULTS AND DISCUSSION

All data were analysed using IBM SPSS software version 23. The descriptive statistics of age, height, weight, and BMI were done. Descriptive statistics for the McGill test battery, the FMS movement screen score for seven individual movement patterns, and scores for the ten tests under the bunkies test were done.

Table 1: Description of age, height, weight and BMI of the participants

Description	N	Minimum	Maximum	Mean	Std. Deviation
Age in years	20	20.00	25.00	22.9000	1.61897
Height in cms	20	157.00	177.00	166.4500	5.42388
Weight in kgs	20	53.00	73.00	64.0000	6.46448
Body Mass Index	20	20.00	25.00	23.0250	1.55998

Table 2: Description of the individual tests under McGill core stability test battery

Test	N	Minimum	Maximum	Mean	Std. Deviation
Flexion torso test in seconds	20	74.00	136.00	89.5000	15.56819
Extension torso in seconds	20	67.00	139.00	84.5000	17.20924
Right lateral bridge in seconds	20	45.00	89.00	63.8500	9.96982
Left lateral bridge in seconds	20	43.00	91.00	61.5000	10.77277

Table 3: Description of the 7 individual tests comprising the FMS – Functional Movement Screening

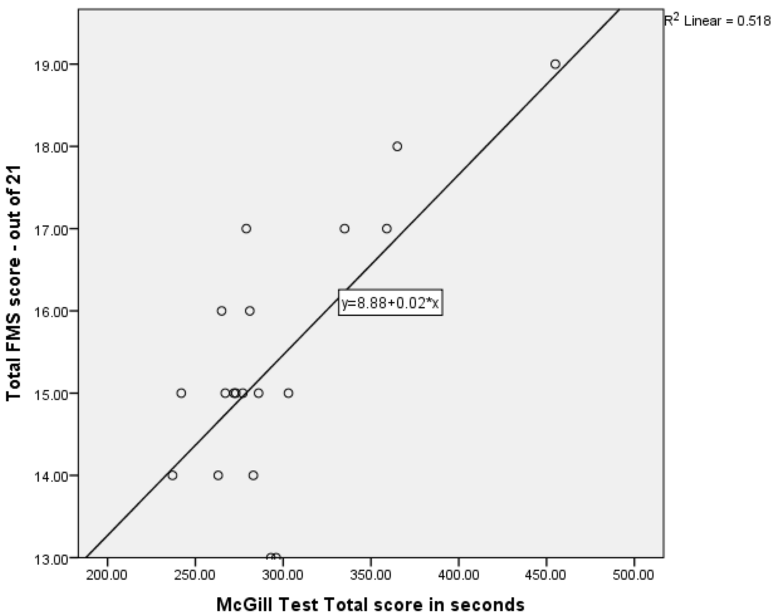
Test	N	Minimum	Maximum	Mean	Std. Deviation
Deep Squat	20	1.00	3.00	2.0500	.39403
Hurdle Step	20	2.00	3.00	2.5500	.51042
Inline lunge	20	1.00	3.00	2.4000	.59824
Shoulder Mobility	20	2.00	3.00	2.7000	.47016
Active SLR	20	1.00	3.00	2.1500	.58714
Trunk Stability Push Up	20	1.00	3.00	2.2000	.76777
Rotary Stability	20	1.00	3.00	1.5000	.60698

Table 4: Description of the ten test positions under Bunkie test

Test	N	Minimum	Maximum	Mean	Std. Deviation
Posterior power line (left side) in seconds	20	29.00	62.00	46.2000	7.45230
Posterior power line (right side) in seconds	20	34.00	57.00	45.7000	6.27526
Posterior stabilising line (left side) in seconds	20	31.00	45.00	37.2500	4.30269
Posterior stabilising line (right side) in seconds	20	29.00	49.00	37.5500	4.63936
Anterior power line (left side) in seconds	20	31.00	57.00	44.7000	7.58877
Anterior power line (right side) in seconds	20	34.00	62.00	47.8500	7.88920
Lateral stabilising line (left side) in seconds	20	28.00	50.00	39.4500	6.19401
Lateral stabilising line (right side) in seconds	20	30.00	48.00	38.2000	5.90807
Medial stabilising line (left side) in seconds	20	29.00	46.00	36.6500	4.46360
Medial stabilising line (right side) in seconds	20	24.00	44.00	36.0000	6.06977

Table 5: Pearson's correlation was done to establish the correlation between the core stability assessed by the total score of McGill test battery, double leg lowering test and seated medicine ball throw test.

Pearson's Correlation Analysis		McGill Test Total score in seconds	Double leg lowering test in degrees	Medicine ball throw test in metres	Total FMS score - out of 21	Bunkie test total score in seconds
McGill Test Total score in seconds	Pearson Correlation	1	-.782**	.756**	.719**	.685**
	Sig. (2-tailed)		.000	.000	.000	.001
Double leg lowering test in degrees	Pearson Correlation	-.782**	1	-.602**	-.571**	-.501*
	Sig. (2-tailed)	.000		.005	.009	.024
Medicine ball throw test in metres	Pearson Correlation	.756**	-.602**	1	.711**	.674**
	Sig. (2-tailed)	.000	.005		.000	.001
Total FMS score - out of 21	Pearson Correlation	.719**	-.571**	.711**	1	.933**
	Sig. (2-tailed)	.000	.009	.000		.000
	N	20	20	20	20	20
Bunkie test total score in seconds	Pearson Correlation	.685**	-.501*	.674**	.933**	1
	Sig. (2-tailed)	.001	.024	.001	.000	
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						



1. Linear regression was used to analyse the relationship between McGill core stability test battery (total score) and total FMS Score (out of 21).

Table 6: Describing the relationship between McGill core stability test battery and Bunkie test.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	212.990	50.019		4.258	.000	107.904	318.075
	McGill Test Total score in seconds	.657	.165	.685	3.985	.001	.310	1.003
a. Dependent Variable: Bunkie test total score in seconds								

Model Summary					
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Durbin-Watson**
1	.685a	.469	.439	37.03194	2.294
a. Predictors: (Constant), McGill Test Total score in seconds					
b. Dependent Variable: Bunkie test total score in seconds					

The results showed a strong correlation between core stability tested by the three-method McGill test battery (DLLT and seated medicine ball throw test) and the functional movement screen (FMS) and the bunkie test, which are both injury risk predictors. In addition to that, better core stability was statistically significant with better scores in the FMS and the bunkie test, indicating that the better the core, the lower the injury risk. The results also proved that total bunkie test score and total FMS score had strong correlation.

Table 7: Correlation between FMS score and Bunkie test score.

Test Score		Total FMS score - out of 21	Bunkie test total score in seconds
Total FMS score - out of 21	Pearson Correlation	1	.933**
	Sig. (2-tailed)		.000
Bunkie test total score in seconds	Pearson Correlation	.933**	1
	Sig. (2-tailed)	.000	
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 8: The mean values of each of the 7 movement patterns tested through FMS

Movements	Deep Squat	Hurdle Step	Inline lunge	Shoulder Mobility	Active SLR	Trunk Stability Push Up	Rotary Stability
N	20	20	20	20	20	20	20
Mean	2.0500	2.5500	2.4000	2.7000	2.1500	2.2000	1.5000

This study aimed to investigate the relationship between the McGill core stability test and FMS score as well as the bunkie test score in young competitive male athletes who were injury-free and apparently healthy.

Performance in sports is believed to be closely related to core stability. Core stability was assessed with the McGill test battery, which has high reliability (Waldhelm *et al.*, 2012). Core strength was correlated with the FMS score, which also happens to be a predictor of injury risk. Each of the seven movements screened through FMS demands stability as well as mobility of various joints, which coordinate to perform the movement pattern. A lower score in any of the movement patterns in FMS would indicate a lower level of stability in the joint segments used for that particular movement pattern. Among the seven movement patterns performed in FMS, the highest mean value was achieved in the shoulder mobility test, followed by hurdle step inline lunge, trunk stability push up, active SLR, and deep squat, all values between 2 and 3. The lowest mean score was for rotary stability (1.50). This could have been due to the fact that the samples consisted more of track athletes than those who performed throws (shot put, discus, javelin, or hammer throw). It also points out the fact that rotary stability was the most difficult of the FMS movement patterns to perform. Hence, when training the core, the rotary stability component has to be given due importance. Naturally, the shoulder mobility score was high, as track athletes use their upper extremity and shoulder movements in particular to gain traction while trying to achieve higher speeds.

The bunkie test consists of five tests done on either side for a total of ten scores. The scores of the bunkie test indicate the core stability and endurance and integrity of the fascial lines, and they are also used as an injury risk predictor. Analysing the bunkie scores, the mean values were higher on the left side except for the anterior power line and the posterior stabilising line, which could be due to the fact that the running athlete leans more to the left side when negotiating the curves in the 400-metre track where they train or compete. As most of the participants were track athletes, it could have influenced the scores on their left side.

The linear regression analysis between McGill test scores and FMS scores indicated a moderate to strong relationship between the two variables, emphasising that core stability increases the FMS score and also indirectly decreases the injury risk. As the bunkie test is also used as an injury risk predictor, it was also correlated with core stability, and the results tipped towards a stable core directly correlating with the bunkie score.

Both predictors of injury risk correlated with core stability, establishing a positive relationship and stressing the importance of core training for reducing injury risk in athletes. Competitive athletes gain major benefits by reducing their injury risk, which will directly translate to better performance and longevity in their careers. But it has to be kept in mind that only the risk of indirect injuries can be minimised. Since athletics, especially track events, are non-contact sports events, better core stability will have a positive effect on injury prevention.

Athletes who want to enhance their basic movement patterns and core stability test scores might consider adding core stability exercises to their regular training regimen (Majewska *et al.*, 2022). Core training is a relatively recent kind of strength training that has been shown to improve efficiency by increasing spinal stability and stiffness and decreasing energy loss at the terminal segment (Luo *et al.*, 2022). General athletic performance improves with core training, but not sport-specific performance. To enhance performance in a certain sport, it is vital to develop foundational training programmes (Dong *et al.*, 2023).

This study also provides details of dynamic core tests like the double leg lowering test (which amplifies lower core stability) and the seated medicine ball throw test (which amplifies upper core stability) having a positive correlation with core stability measured by the McGill test battery.

CONCLUSION

The results of the study conclude that the McGill core stability test battery is correlated to the FMS score and to the bunkie test score, both of which are used as injury risk predictors. The core stability measured by the McGill test battery is correlated to the DLLT and the seated medicine ball throw test. Training the core and improving core stability could have a positive effect on reducing injury risk in track and field athletes.

FUTURE SCOPE

This study does not attempt to relate core stability to performance parameters. The major limitations of this study are that the sample size was limited, and the study was restricted to young male track and field athletes only. Further studies can be performed on female subjects and sportspersons involved in different sports with a larger sample size. The effect of training the core on FMS and bunkie scores, on minimising injury risks, and on improving sports performance can also be studied with larger sample sizes.

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