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Abhilash PV
Associate Professor, Department of Physiotherapy, Rajiv Gandhi University of Health Sciences, Mangalore, Karnataka, India

Sudeep Shetty
Professor and HOD, Department of Orthopaedics, Rajiv Gandhi University of Health Sciences, Mangalore, Karnataka, India

Anjana K
Post Graduate Student, Department of Physiotherapy, Rajiv Gandhi University of Health Sciences, Mangalore, Karnataka, India

Corresponding Author:
Anjana K
Post Graduate Student, Department of Physiotherapy, Rajiv Gandhi University of Health Sciences, Mangalore, Karnataka, India

Relationship between core endurance and dynamic balance in professional basketball players: A pilot study

Abhilash PV, Sudeep Shetty and Anjana K

Abstract
Background: The Core strength is an important precondition for basketball players. The good balance in basketball sports provides a controlled body for players, minimizes their errors, quick movers, and effective technical skills. The study was to determine the relationship between core endurance and dynamic balance in Professional basketball players.
Methodology: A pilot study was conducted on 20 professional basketball players between 18 to 28 years of age. Core endurance was assessed using the McGill core endurance test and dynamic balance was assessed using the star excursion balance test.
Results: Karl Pearson’s correlation coefficient test was used to find the relation between the core endurance and dynamic balance. There was a positive correlation between core endurance and dynamic balance of bilateral leg ($r = .471$, $P<0.05$), ($r = .457$, $P<0.05$) which was statistically significant.
Conclusion: This study indicates that in professional basketball players regular core endurance training program improves their dynamic balance, which can eventually lead to reduce the risk of injury and better performance.

Keywords: core endurance, dynamic balance, professional basketball players

Introduction
The FIBA a Basketball tourney is one amongst the foremost prominent basketball competitions within the world, with elite players from various countries competing against one another for the title of World Champion [1]. Basketball is a particularly popular sport played throughout the globe. Among noncontact sports, basketball has the greatest incidence of injuries. The foremost common injuries in basketball are reported to involve the ankles, knees, and lower back [2]. Basketball may be physically demanding a sport characterized by intensive body contact, frequent intermittent running, and jumping, demanding one-on-one situations, quick direction changes together with challenging technique, and coordination aspects like catching, throwing, passing, sprints, dribbling, and low-intensity activities like walking, stopping and jogging. One of the 2 main purposes of basketball is to form an honest shot to get and therefore the other one is to require necessary precautions against the opponent who is trying to attain by shooting [3, 4]. In basketball, the flexibility to come up with maximal strength levels within the shortest period of time (a muscular power) has been considered essential to get high sport performance levels. Moreover, strength training is an element of basketball preseason programs with a background of related benefits that improve sports performance, reduce an injury rate, and supply higher motivation levels for the athletes [5]. Sport has been reported to impose important physiological loads on players during competition [6].
The Core strength is a crucial precondition for basketball players, to perform sport skills and to perform some everyday activities like walking, climbing stairs, postural control [7]. Optimal core stability is additionally important for the performance of athletic movements leading to body oscillations outside the support surfaces of the athletes [8].
The good balance in basketball provides a controlled body for players minimizes their errors, protects against the drop when changing their directions, quick movers, and effective technical skills [4]. Basketball; requires the players to habitually address physical contact and various situations involving balance instability, like basketball-specific accelerations and decelerations,

changes in direction, penetrations into the defensive perimeter, boxing out dribbling, and defense position recovery. These actions are often performed during a very limited space and need very fast movement, high coordination ability, and appropriate strength [9].

Core stability is that the ability to manage the position and motion of the trunk over the pelvis and leg to permit optimum production, transfer, and management of force and movement to the terminal section in included kinetic chain activities [10]. The core is very important in providing local strength and balance [11]. The core is that the centre of the functional kinetic chain providing the proximal stability for the distal mobility and performance of the limbs. The core stability is vital to prevent injuries and improve performance in athletes. Weak core muscles are also a risk factor for low back pain [12]. A strong core allows a person the complete transfer of forces generated from the bottom through the lower extremities, the torso, and finally to the upper extremities. A weak core is believed to cause alterations within the transfer of energy, leading to reduced sports performance and risk of injury to a weak or underdeveloped muscle group [13]. The gravitational centre within the lumbopelvic region is where all movements are initiated, but during activity, the centre of gravity is continually shifting. The musculature that surrounds the centre of gravity plays an important role in motor function by maintaining a stable base to support the body mass [14]. More attention paid to the core region, because it is a muscular corset that works as a unit to stabilize the body and spine during all actions with or without limb movement, core stability, and strength endurance is a very important component to maximizing equilibrium and movements athletic function with upper or lower limb [15]. The gains in strength and endurance of the core muscles are vital in reducing disability as they maintain and stabilize the spinal segments during activity similarly as against external forces [16]. Certain muscles are needed to be analysed to see core stability and core strength. These muscles include the transverse abdominis, internal oblique, external oblique, rectus abdominis, erector spinae, quadratus lumborum, and latissimus dorsi. The combinations of those abdominal and back muscles provide stability to the spine and hips. These muscles also provide the power to provide flexion, lateral flexion, rotational movements, and control external forces that cause extension, flexion, and rotation of the spine. The anatomy of the rectus abdominals provides minimal forward movement when contracted [17].

The core plays a crucial role in reducing the chance of injury and stabilizing peripheral joints, especially during intense physical activity. McGill’s tests had been used to observe individuals’ core endurance. These tests consisted of 4 positions: the trunk anterior flexor test, right and left lateral plank, and trunk posterior extensor test [18].

Dynamic balance is a vital factor related to lower extremity injury and performance in athletes [13]. Balance is defined as an ability to maintain a base of support with minimal movement actions and dynamically to perform a motor task while maintaining a stable position. Balance is that the ability to maintain dynamic integration of interior and exterior forces during motor action tasks [13]. Dynamic balance reasons the center of gravity to transport in reaction to muscular activity. This muscular activity may also take place via any supply of external or internal disturbance. During the dynamic activity, the center-of-pressure moves between the base of support boundaries and sometimes outside the base of support [19] because the center of mass moves far from the base of support, there's an increased potential for biomechanical deviations to occur within the lower extremity [20]. Dynamic balance refers to maintaining equilibrium during motion or re-establishing equilibrium through rapid and successively changing positions [21]. In a game player often perform single-leg reaching movements outside their base of support during intense lateral running, sprinting, and jumping movements, usually with a change of activity every 4-6 seconds [21]. The skill requirements and environmental demands of sports likely pose different challenges to the sensorimotor systems that cumulatively may influence the balance abilities of trained athletes [22]. Balance could be a vital aspect of performance and injury risk in many different sports activities. Supported the current evidence, it appears that poor balance and inappropriate postural control were associated with increased risk of recurrent sprain which can affect both athletic performance and activities of daily living [23].

Balance is the ability to take care of postural stability while standing on one leg and performing a reach with the opposite leg as described when performing the Star Excursion Balance Test (SEBT). SEBT is one such test that involves a series of single-limb excursions in several directions, to maintain the base of support on the stance leg and reach maximum excursion with the alternative leg [24]. Researchers have proposed that improved balance could decrease the number of musculatures involved in stabilization, allowing more muscles to contribute to force production during a given movement [24]. Ankle sprains are the foremost common sports injuries among athletes. It’s very true in sports like basketball requiring frequent jumping and directional changes. Athletes who sprain their ankle are susceptible to reinjure within the same ankle. The rate of reinjuring will be as high as 70% to 80%, resulting in chronic ankle instability in 20% to 50% of those cases. Following an ankle sprain, damage of sensory receptors of the ligament may end up in proprioceptive deficits. After the ligamentous injury, proprioception deficiency increases body sway. In other words, balance is going to be disturbed [23].

Basketball coaches regularly train fitness and basketball skills in young players [25]. Assessment of the physical capacities of athletes is one of the foremost important issues in modern sports, many tests are employed so selection procedures, for screening candidates, or observing the efficacy of coaching regimes [26]. Functional tests are used to evaluate the particular functional ability of an individual, not part of his/her body [27].

Jatin P *et al.* did a study on athletes, and they concluded that there's no relationship exists between core muscle endurance and balance [28]. T Tsukagoshi *et al.* did a study on handball and basketball players which concluded that core strength has a certain relationship to the dynamic balance and it's going to help for the prevention of sports injuries [29]. Few researchers did a study to know the risk of injury and balance control by training the core stability musculature and showed that the trunk muscle fatigue may cause reduced dynamic stability of trunk and loss of balance control. Any variation in core stability and dynamic balance performance in basketball players is often a big risk for sports-related lower extremity injuries. So early identification of reduced core endurance level and dynamic balance may be promoted for developing future rehabilitation and thus helps in giving proper training for basketball players and reduce risk of injuries. There are inconsistent results in the literature regarding the relationship between core endurance and dynamic balance in professional basketball players. So, this study aims to understand whether any relationship exists between core endurance and dynamic balance in professional basketball players.

Materials and Methods

A Pilot Study was conducted on 20 professional basketball players for 3 months. A convenience sampling technique was used to include the participants in the study. Ethical clearance became received from the institutional ethical committee. The subjects were enrolled according to the inclusion and exclusion criteria. The inclusion criteria were male professional basketball players, Age group 18-28 years, Basketball players who have been engaged in sports for at least 2 years, training 5 days a week (upper body lift and conditioning, Agilities and lower body lift), Participants who were free from injury. The exclusion criteria were participants with previous lower extremity musculoskeletal injuries, Participants who had low back pain, any history of the upper extremity or lower extremity surgery, those with upper extremity and lower extremity deformities, any neurological problems which alter the balance, Any vestibular disease, Any systemic disease. This study involved minimal equipment such as a Table, Exercise mat, a stopwatch, Measuring tape, and pen/pencil, Paper

Procedure

At first, informed consent was obtained from the participants. A brief introduction to the procedure was explained to all the subjects. Participants were recruited on basis of the inclusion and exclusion criteria. After the recruitment, an initial examination including demographic data, BMI, limb length was carried out before the study.

Outcome measure

To assess core endurance by McGill's Core Endurance Test and to assess dynamic balance by Star Excursion Balance Test.

McGill's core endurance test

The tests consisted of four positions; the test was recorded per position where the most time (seconds) participants can hold a static position was measured using a stopwatch. Trunk anterior flexor test: participants sat with their backs flat against a wooden wedge angled at 60º with hands across their chest and their knees both flexed to a 90º angle as determined by a goniometer. Time recording started when the wedge was moved back 10 cm, and stopped when the trunk deviated either forward or backward from the 60º angle. Left and Right lateral musculature plank test: participants' feet were placed one on top of the opposite, the right arm was perpendicular to the ground, elbow resting on the mat, with the left arm across the chest. The same position for the right lateral musculature plank. Time was stopped when the investigator visually determined that the line between the participants' trunk and lower body segments (thigh or shank) wasn't maintained. Trunk posterior extensor test, individuals lay prone on an exam desk with each of their ASIS's on the edge of the desk, their palms at the seat of a chair positioned earlier than of them at the edge of the desk. An assistant held straps above and beneath their knees to stable participants' lower bodies. Time turned into began out while individuals assumed a horizontal position of the trunk, putting their palms off of the chair and crossed them throughout their chest, and stopped while individuals have been not able to stay in that position.

Star excursion balance test

The maximum reach distance of the unsupported limb is measured, when the participants are in a unilateral stance, with the foremost distal aspect of the great toe at the starting line. SEBT was performed in anterior, posterolateral, and posteromedial directions bilaterally. All participants were taught the way to perform the test by the identical investigator using both verbal instruction and a demonstration. The maximal reach distance was measured by marking the tape with erasable ink at the point where the foremost distal a part of the foot reached. The best of three trials for every reach direction was used for an analysis of the reach distance in each direction. Also, the best reach distance from each direction was summed normalized to a limb length (%LL, cm) to yield a composite reach distance for an analysis of the performance on the test. The method was repeated while standing on the opposite leg.

Statistical analysis

Demographic characteristics of the participants based on age, BMI, limb length, and practicing hour/day analysis were done by descriptive statistics. Karl Pearson correlation coefficient test was used to find the relationship between core endurance and dynamic balance in professional basketball players. P value <0.05 was considered significant. The data were analysed using Microsoft Excel and SPSS 21.

Results

The study consists of 20 professional basketball players. The mean age (in years) of the study participants was 21.6 years with a standard deviation of 2.5 years. The mean value of BMI is 24.3 ± 2.45. The mean limb length of the left leg was 96.5 ± 6.69 and the right leg length was 96.45 ± 6.75. Mean value of practicing hour per day 2.1 ±.55. All SEBT and McGill's core endurance was done in descriptive statistics (mean and standard deviation) [Table 1]. Karl Pearson's correlation coefficient test was used, the result of the present study suggested that there is a relationship between core endurance and dynamic balance in professional basketball players. In the right leg, a positive correlation was observed between core endurance (flexion) and dynamic balance. However, the correlation was found to be statistically significant (r = 0.471, $P<0.05$) [Table 2]. In the left leg, the correlation was found to be statistically significant between core endurance (flexion and extension) and dynamic balance (r = 0.457 $P<0.05$), (r = 0.453 $P<0.05$) [Table 3].

Table 1: SEBT and McGill's test (Mean + SD)

Test	Side	Direction	Mean	SD
SEBT	Right	A	92.25	10.33
		PL	112.95	23.07
		PM	103.95	11.17
		Composite score	110.90	10.77
	Left	A	94.75	12.81
		PL	113.25	10.09
		PM	103.70	9.43
		Composite score	109.92	11.33
McGill's tests		Trunk flexor	96.50	37.09
		Trunk extensor	70.55	18.82
		Right lateral	58.90	8.49
		Left lateral	65.00	13.45

Abbreviations: A-Anterior; PL-Posterolateral; PM-Posteromedial

Table 2: Correlation between core endurance and dynamic balance of right leg

		SEBT right leg
Flexion	Pearson Correlation	.471*
	Sig. (2-tailed)	.036
Extension	Pearson Correlation	.338
	Sig. (2-tailed)	.145
Right plank	Pearson Correlation	.126
	Sig. (2-tailed)	.596
Left plank	Pearson Correlation	.332
	Sig. (2-tailed)	.153

Table 3: Correlation between core endurance and dynamic balance of left leg

		SEBT left leg
Flexion	Pearson Correlation	.457*
	Sig. (2-tailed)	.043
Extension	Pearson Correlation	.453*
	Sig. (2-tailed)	.045
Right plank	Pearson Correlation	.189
	Sig. (2-tailed)	.424
Left plank	Pearson Correlation	.396
	Sig. (2-tailed)	.084

Discussion

In basketball, jumping and landing are important for the successful performance of both defensive and offensive skills. Making the transition from a jump to another skill is also important for successful performance, thus landings need to occur in a balanced position and with a correct technique [20]. The good balance in basketball provides a controlled body for players minimizes their errors, protects against the drop when changing their directions, quick movers, frequent jumping, and effective technical skills. So, they require more dynamic balance for activities [24].

A pilot study was conducted to determine the correlation between core endurance and dynamic balance among professional basketball players. Over three months (total study duration), data from 20 subjects fulfilling inclusion criteria were analysed, and an explanation of the procedure was given. The demographical data including age, BMI, limb length, practicing hours/day were recorded.

The present study was to determine the correlation between core endurance and dynamic balance among professional basketball players. This study was done with the age group 18-28 years, Descriptive statistics were used to find out the mean and standard deviation from demographic data and variables studied, and the mean age (in years) of the study participants is 21.6 years with the standard deviation of 2.5 years. Gonzalo-Skok O *et al.* suggested that the age of the player should be considered when interpreting the SEBT score, which could have implications when implementing the SEBT for injury risk prediction [30].

The present study shows that the body mass of basketball players with a mean value is 24.3 ± 2.45. Hartley EM *et al.* identified that male collegiate athletes with greater BMI and lesser YBT anterior reach were at a greater risk of sustaining an ankle sprain injury [31]. Descriptive statistics were used to find out the mean and standard deviation, with the mean value of limb length of the left leg was 96.5 ± 6.69 and right leg length was 96.45 ± 6.75. In this study SEBT maximal reach distance in the anterior, posteromedial, and posterolateral directions normalized to lower limb length; composite-reach score normalized to lower limb length. Also, the mean of practicing hours per day 2.1 ±.55.

In this study, McGill's core endurance test was used to assess core endurance and the star excursion balance test was used to assess dynamic balance.

Karl Pearson's correlation coefficient test was used, correlating the core endurance with right leg dynamic balance shows that, a positive correlation was observed between core endurance (flexion) and dynamic balance. The correlation was found to be statistically significant (r = 0.471, $P<0.05$), and correlating the core endurance with left leg dynamic balance, a positive correlation was observed between core endurance (flexion, extension) and dynamic balance (r = 0.457 $P<0.05$), (r = 0.453 $P<0.05$) which was statistically significant.

Our results were similar to those of T Tsukagoshi *et al.* [29] who investigated that the core strength had a certain relationship to the dynamic balance and may contribute to the prevention of sports injuries. The researchers evaluated endurance time of right side-bridge, left side-bridge, and frontal-bridge were included as the core strength test (CST), Static balance was assessed using stabilometer and dynamic balance, using star excursion balance test (SEBT). They reported that in the dynamic balance, the players with a good result of CST score had significantly better results of the SEBT in frontal-bridge and left side-bridge. Similar findings were seen in other studies Hassan Sadeghi [19] who determines that the effects of a core stability program on the dynamic balance of volleyball players as measured with the Star Excursion Balance Test (SEBT). They demonstrated that core stability training could be beneficial for improving balance by strengthening core muscles most often associated with lumbar spine control to improve dynamic balance. In contrast, Jatin P. Ambegaonkar *et al.* [28] showed that Core endurance and SEBT scores were not correlated in collegiate female athletes.

The limitation of the study was the population of the study was done only on male basketball players, Lower limb ROM and muscle flexibility which might influence reaching ability were not recorded in our study and the participants were recruited from a particular area.

Conclusion

The Present study concluded that there was a positive correlation between core endurance (flexion and extension) and dynamic balance in professional basketball players. This study indicates that in professional basketball players regular core endurance training program improves their dynamic balance, which can eventually lead to reduce the risk of injury and better performance. The clinicians can use the SEBT to monitor patient progress and guide clinical decision-making for a rehabilitation program. By using these tests early identification of reduced core endurance level and dynamic balance can be useful for developing future rehabilitation and thus helps in giving proper training for basketball players.

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