Original Article

DOI: 10.7860/JCDR/2025/74543.20716

Physiotherapy Section

Relationship between Lower Limb Flexibility, Power, Agility and Speed in Football Players: A Cross-sectional Study

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ABSTRACT

Introduction: Football is a complex game characterised by unpredictable movement patterns. 17% of injuries in football have been attributed to tightness in the hamstring muscles and a lack of flexibility. In football, the ability to quickly change direction, produce a high rate of power output, and sprint at high velocity is essential for optimal performance. The effect of lower limb flexibility and its relationship to skills required in football, such as agility, power, and speed, have not been previously studied.

Aim: To examine the relationship between lower limb flexibility, power, agility, and speed in football players.

Materials and Methods: This cross-sectional study was carried out in the football field of Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat, India on 30 male football players who played at Sumandeep Vidyapeeth campus from January 2021 to August 2021. Football players aged between 18 to 25 years who had been involved in regular football training sessions atleast three times per week for the past year were included in the study. Participants with a history of musculoskeletal injuries to the back, shoulder, elbow, or lower limb within the past six months, or those with any history of cardiorespiratory or neurological problems that could affect test performance, were excluded. Apart from anthropometric measurements, participants were assessed for flexibility using the Active Knee Extension Test (AKET) and the V-sit and reach test, agility using the Arrowhead Agility Test (AAT), power using the Vertical Jump Test (VJT), and sprinting ability using the 40-yard dash test. Correlations among flexibility, agility, power, and speed were assessed using Pearson's correlation coefficient. Statistical significance was set at p-value<0.05.

Results: Total 30 participants were recruited, with a mean age of 20±1.5 years and a mean Body Mass Index (BMI) of 22±1.7 kg/m². The mean active knee extension angle for the right-side was 25±1.9°, and for the left-side, it was 24.6±8.5°. The mean value for the sit and reach test was 42±1.5 cm, the vertical jump was 44±7.9 cm, the AAT was 9.1±1.5 seconds, and the 40-yard dash test was 6.5±0.91 seconds. A significant positive correlation was found between AKET and AAT (r=0.482, p-value=0.007) and between the V-sit and reach test (VSRT) and VJT (r=0.491, p-value=0.006). However, no statistically significant correlations were found between AKET and VJT, AKET and the 40-yard dash, AAT and VJT, or VJT and the 40-yard dash.

Conclusion: A positive correlation was found between hamstring flexibility with agility and negative correlation was found between hamstring flexibility with power. There was no statistically significant correlation found between flexibility and sprint.

Keywords: Correlation, Hamstrings, Vertical jump test, V-sit and reach test

INTRODUCTION

Football, also called soccer, is the most popular sport in the world, played by participants of both genders and spanning all age groups [1,2]. Football involves explosive activities to maintain control of the ball and balance [3]. It requires rapid force generation, high power output, and the ability to efficiently utilise the stretch-shortening cycle [4].

Limited muscle flexibility, along with muscle strength, predisposes the muscle to injury and impairs performance. According to García-Pinillos et al., lack of flexibility accounts for 17% of injuries in football [4]. Comerford and Mottram noted that as multi-articular muscles are linked in a functional chain, any lack of extensibility must be compensated for elsewhere in the movement system [5]. Tight muscles do not allow for rapid elongation without injury. If the musculotendinous system is stiff, it creates more resistance during eccentric contraction; conversely, if it is compliant, it reduces the chances of injury by transferring the load to the tendon. Poor hamstring flexibility is a common risk factor for hamstring strains [6], which can be assessed using various tests [7,8]. Neto et al., reported a reliability coefficient of r=0.91 for the AKET to measure hamstring flexibility [9].

While playing, lower body power is crucial for executing stops, changes in speed, and direction [10]. The VJT evaluates physical performance; it is easy to perform and cost-effective, although it does not measure power directly [11]. Moderately significant correlations exist between hamstring flexibility and vertical jump performance [12]. The intra-evaluator reproducibility of the VJT is 0.99 [13].

Agility refers to the ability to maintain body positions correctly and efficiently while quickly starting, stopping, and changing direction in a serial manner [14]. Soccer/football is a sport that requires repeated intermittent sprints. During a 90-minute football match, players may perform close to 600 changes of direction [15]. Agility can be evaluated using the AAT, which has been found to be valid and reliable (ICC=0.76 to 0.85) in football players [16].

During a match, a player performs anywhere from 1,000 to 1,400 actions within a short duration. Sprints lasting 2 to 4 seconds are repeated approximately every 90 seconds. These anaerobic efforts are essential for success in sports [17]. More than 90% of sprints are reported to be shorter than 20 meters, indicating that the ability to accelerate is crucial for football players [18]. A strong correlation exists between flexibility and speed in football players. One study reported that velocity demands may cause hamstring shortening, leading to low elasticity, which can limit actions required in stretch-shortening cycles. To prevent further injuries, it is important to maintain good flexibility [19]. The 40-yard dash test, which evaluates sprint speed, is also used in recruiting and evaluating players, assessing a player's potential for professional level competition. Its relative reliability and interclass correlation coefficient is 0.987 [20].

Very few papers have analysed the effect of lower limb flexibility and how it relates to skills required in football, such as agility, power, and speed [4]. Therefore, the present study was undertaken to examine whether there is any relationship among football players between lower limb flexibility, agility, power, and speed.

Null hypothesis: There is no statistically significant correlation between lower limb flexibility, agility, power, and speed in football players.

Alternate hypothesis: There is a statistically significant correlation between lower limb flexibility, agility, power, and speed in football players.

MATERIALS AND METHODS

This cross-sectional study was conducted in the football field of Sumandeep Vidyapeeth Deemed to be University, campus Gujarat, India on male football players who played at Sumandeep Vidyapeeth campus from January 2021 to August 2021. The present study was approved by the Institutional Ethics Committee (SVIEC No: SVIEC/ON/PHYS/BNMPT19/D20021) and registered with the Clinical Trials Registry of India (CTRI No: CTRI/2020/10/028323).

Inclusion and Exclusion criteria: Football players aged between 18 and 25 years who had been involved in regular football training sessions atleast three times per week for the past year were included in the study. Those with a history of musculoskeletal injuries to the back, shoulder, elbow, or lower limb in the past six months, or those with any history of cardiorespiratory or neurological problems that may affect performance in the tests, as well as players who played less than three times per week, were excluded.

The study was explained to the participants, and written informed consent was obtained from those who were willing to participate. Anthropometric measurements such as age, gender, BMI, and the number of years played in football, among others, were recorded [21]. The physical tests were explained to the participants.

Study Procedure

The primary outcome measures of the study are detailed below. (As present study was conducted during the second wave of the Coronavirus Disease-2019 (COVID-19) epidemic, the sample size was not calculated; however, the study included all participants who were willing to participate).

1. V-sit and reach test [14]: This test was conducted to measure lower limb flexibility according to standard procedures [14]. The test is shown in [Table/Fig-1]. The test was repeated three times. The distance from the starting position to the reach position was measured in centimeters, and an average of the three readings was determined [Table/Fig-1].

[Table/Fig-1]: Player performing V-sit and reach test.

2. Active Knee Extension Test (AKET) [9]: This test was conducted to measure hamstring flexibility according to standard procedures [9]. The test is shown in [Table/Fig-2]. The task was performed three times, and the average of the three readings was calculated. Participants who were weak were excluded from the study.

[Table/Fig-2]: Players performing Active Knee Extension Test (AKET).

3. Vertical Jump Test (VJT) [13]: This test was conducted to assess lower limb muscle power according to standard procedures [13]. The test is shown in [Table/Fig-3]. The average of three trials was recorded. Vertical jump performance was calculated as maximal jump height minus reach height (cm) [Table/Fig-3].

[Table/Fig-3]: Player performing Vertical Jump Test (VJT).

4. Arrowhead Agility Drill Test [22]: This test was conducted to assess the agility of players according to standard procedures [22]. The test is shown in [Table/Fig-4]. The participant completed a total of four trials, two on the right-side and two on the left-side. The time taken to complete the test was recorded in seconds [Table/Fig-4].

[Table/Fig-4]: Player performing Arrowhead Agility Test (AAT).

5 Forty yard dash test [20]: This test was conducted to assess the sprinting ability of players according to standard procedures [20]. The test is shown in [Table/Fig-5]. Two trials were performed, and the best time was recorded. Note that 40 yards equals 36.58 meters [Table/Fig-5].

[Table/Fig-5]: Players performing 40-yard dash test.

STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS) version 22.0 was used for the analysis. Data were expressed as the mean±standard deviation for age, weight, BMI, playing time, exercise, and all outcome measures. Normal distribution was assessed using the Kolmogorov-Smirnov test. In present study, all statistical tests were performed with a 95% confidence interval. Correlations among flexibility, agility, power, and speed were assessed using Pearson's correlation coefficient. Statistical significance was set at $p<0.05$.

RESULTS

Total 30 participants were recruited for the study, with a mean age of 20±1.5 years and a mean BMI of 22±1.7 kg/m^2. The mean playing time of participants was 2.9±1.3 years, as shown in [Table/Fig-6]. The mean active knee extension angle for the right-side was 25±1.9 degrees, and for the left-side, it was 24.6±8.5 degrees. The mean values for the sit and reach test were 42±1.5 cm, for the vertical jump it was 44±7.9 cm, for the AAT it was 9.1±1.5 seconds, and for the 40-yard dash, it was 6.5±0.91 seconds, as shown in [Table/Fig-7]. Participant demographic details are provided in [Table/Fig-6].

Variables	Mean±SD
Age (year)	20±1.5
Height (cm)	167±7.7
Weight (kg)	63±5.4
BMI (kg/m2)	22±1.7
Play sport	
Playing time (years)	2.9±1.3
Days	4.7±0.89
Hours	1.1±0.30
Exercise	
Exercise days/week	5±0.35
Exercise time/day (hours)	1.1±0.29

[Table/Fig-6]: Demographic data.

Variables	Mean±SD
Active knee extension RT (degree)	25.1±9
Active knee extension LT (degree)	24.6±8.5
V sit and reach (cm)	42±15
Vertical jump (cm)	44±7.9
Arrowhead agility (sec)	9.1±1.5
40 YARD DASH (sec)	6.5±0.91

[Table/Fig-7]: Mean±SD of all outcome measures.

The mean and standard deviation of the various outcome measures: AKET, sit and reach test, VJT, AAT, and the 40-yard dash test has been depicted in [Table/Fig-7]. The correlation of AKET with the agility test, vertical jump test, and 40-yard dash test. There was a statistically significant positive correlation between flexibility, as assessed by AKET, and agility has been depicted in [Table/Fig-8]. However, there was no statistically significant correlation between flexibility and power, nor between flexibility and speed.

Name of the test	r	p-value
Active Knee Extension Test (AKET) (RT) and Arrowhead Agility Test (AAT)	0.482	0.007
AKET (LT) and AAT	0.478	0.008
AKET (RT) and Vertical Jump Test (VJT)	-0.046	0.809
AKET (LT) and Vertical Jump Test (VJT)	-0.073	0.703
AKET (RT) and 40 yard dash test	0.316	0.089
AKET (LT) and 40 yard dash test	0.308	0.098

[Table/Fig-8]: Correlation between flexibility (AKET) with agility, power, and speed test.

The statistically significant positive correlation between lower limb flexibility and power in football players has been depicted in [Table/Fig-9]. However, there was no statistically significant correlation between flexibility and agility, nor between flexibility and speed.

Name of the test	r	p-value
V sit and reach test and AAT	-0.303	0.104
V sit and reach test and VJT	0.491	0.006
V sit and reach test and 40 yard dash test	0.160	0.400

[Table/Fig-9]: Correlation between flexibility as assessed by V sit and reach test, with agility, power and speed using Pearson's correlation coefficient.

DISCUSSION

Flexibility, agility, power, and sprint performance were compared in young football players in the present study, which included 30 young male football players. According to Asian-World Health Organisation (WHO) guidelines, all players were categorised as having a 'normal' BMI [22].

Flexibility and Agility

A positive correlation existed between flexibility and agility, indicating that as hamstring tightness increased, agility time also increased. This finding aligns with the study by García-Pinillos et al., which reported that male football players aged 14-18 years had higher agility times when they exhibited poor hamstring flexibility compared to those with good hamstring flexibility [4]. In the present study, the hamstrings were mildly tight according to AKET values. Low back and hamstring flexibility, as measured by the V sit and reach test, fell between the 70th and 90th percentile ranks, indicating good flexibility [23].

A separate study on football injury risk factors in male football players found that these athletes were less flexible in the hip and knee regions [24]. The researchers suggested that high-intensity, short sprints with sudden turns and speed changes, combined with a high volume of these activities and the lack of emphasis on flexibility training, could be probable reasons for the poor lower limb flexibility observed in football players [24,25].

The football players in the present study were college students at a healthcare university who practiced regularly on campus. On average, they had been playing for 2.9 years. They typically played football for about one hour per day after college hours, which limited their playing time. Consequently, most of them prioritised on-field play and allotted less time for warm-up and training. Additionally, 50% of the players trained in the gym outside of football practice and preferred strength training over flexibility training. These factors could contribute to the reduced flexibility observed in our players.

However, a few studies have reported no significant correlation between flexibility and agility in athletes [26-28]. The reasons cited for this discrepancy include the unidirectional nature of flexibility compared to the multi-directional nature of agility, as well as the static nature of flexibility testing versus the dynamic nature of agility testing [27].

Flexibility and Power

A positive correlation existed between flexibility and power, as indicated by the VJT. This finding is supported by other studies that have shown a moderate correlation between hamstring flexibility and vertical jump performance [4,12]. However, some studies have reported no significant correlation between flexibility and vertical jump [29-31]. Hough PA et al., studied how dynamic and static stretching affected vertical jump performance in male athletes. They noted that static stretching enhances the viscoelastic properties of the muscular tendon unit, which diminishes a muscle's force-generating capability by modifying the force-relaxation properties within the muscle [30].

Flexibility and Sprint

The present study did not find any significant correlation between flexibility and speed. The players in present study were students and not professional football players. They devoted less time to training and more time to playing on the field.

Players with greater flexibility tend to have decreased sprint performance immediately following static stretching. Baseline flexibility may influence stretching and athletic performance. Stretching may enhance sprint performance in individuals with low baseline levels of flexibility and may adversely affect those with comparatively high levels of flexibility. This could explain the results found in our population, as they exhibited mild tightness (25.10) [32].

Muscle stiffness is important in relation to stretching and performance. An increased Range of Motion (ROM) is due to decreased stiffness, which leads to reductions in power output. Passive viscoelastic changes may cause a direct decrease in muscle stiffness, while reflex inhibition and viscoelastic changes from decreased actin-myosin cross-bridging can cause an indirect decrease [32]. Compared to the results of present study, other studies found a significant correlation between flexibility and sprint performance [25,33]. The authors of those studies reported that their population exhibited less flexibility compared to ours. They hypothesised that lower limb flexibility could enhance the effect of the treatment.

It may be hypothesised that enhancing the ability to stretch a tight muscle before or during sports activity may improve the performance of an athlete. It is also unclear whether an already flexible athlete requires additional stretching to improve performance [33].

There was a significant positive correlation between agility and speed, as supported by Yıldız S et al. The authors suggested that speed and agility are correlated and thus have the ability to affect each other's performance. During the 5 m zigzag task, repeated deceleration and reacceleration are required of an athlete. Eccentric and concentric forces are produced by an athlete during the phases of deceleration and reacceleration, respectively. A decreased ability of an athlete to eccentrically lower their body mass during deceleration can significantly affect performance in the reacceleration phase, impacting the production of concentric force [34]. There was no statistically significant correlation observed between power and speed or between agility and power.

The study showed a significant positive correlation between flexibility, as assessed by the AKET, and agility, as well as between flexibility assessed by the sit-and-reach test and power in football players; therefore, the null hypothesis is rejected.

Limitation(s)

Football players from only one Institute were included, and the sample size was small. Further studies with a larger sample size can be conducted in the future.

CONCLUSION(S)

The present study assessed the relationship between flexibility using AKET and the V-Sit and Reach test, as well as power (VJT), speed (40-yard dash test), and agility (AAT) in football players. The study showed a significant positive correlation between flexibility assessed by AKET and agility, and flexibility assessed by the sit-and-reach test and power in football players. However, there was no significant correlation between flexibility and speed.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jul 29, 2024
- Manual Googling: Nov 16, 2024
- iThenticate Software: Nov 18, 2024 (11%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Jul 27, 2024**
Date of Peer Review: **Oct 03, 2024**
Date of Acceptance: **Nov 20, 2024**
Date of Publishing: **Mar 01, 2025**