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Relationship between foot variables and jump performance in collegiate basketball players

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Abstract
Introduction: Basketball is a game of speed and vertical jump which involves the rebound, dribble, blocks and jump shots. The players improve their game performance by repeated practicing of jumping and shooting during the practice sessions. Jumping is the most prevalent action performed by basketball players. To perform the action of jump co-ordination from several muscles in arm, trunk and legs are required. The vertical jump height plays a vital role in positioning of the players in basketball. The foot anthropometry and other morphological factors affect vertical jump height. Therefore, the study was done to identify the relationship between foot variables and jump performance in collegiate basketball players.
Materials/Methods: 30 basketball players were selected using convenient sampling method. Body Mass Index, Foot length, Toe length and Arch height were measured for each player using inch tape and weighing machine. Each player was asked to perform vertical jump test thrice and mean value was noted.
Results: Greater jump performance can be achieved with taller stature, lower body weight, minimal foot length, longer toes and greater arch height. The correlation between body weight and jumping height shows p value 0.45 states that weight has negative correlation with vertical jump, whereas body height has a positive correlation with vertical jump with p value 0.73 states that taller stature results in greater jump performance. Foot length and jumping height has a negative correlation with p value 0.74 states that high cost of energy required to raise heels during jump cause a lesser jump performance. However, toe length has a positive correlation with vertical jump height with p value 0.07 stating that longer toes allows more time of contact with the ground creating a greater acceleration due to ground reaction force. Arch height also has a strong positive relation with jumping height with p value 0.00001 states that a high arch is able to store more elastic energy in the tendons during squatting position of jump enabling to use that energy at the takeoff, resulting in a higher jump.
Conclusions: The result of the study showed that these foot variables contribute in selection of position of players in game strategy for better performance in the game.

Keywords: foot variables, vertical jumping height, basketball

Introduction

Vertical jump is one of the most prevalent acts performed by basketball players. Basketball is a game of speed and vertical jump which involves the rebound, dribble, blocks and jump shots [1]. Basketball training academies concentrate on training the regime of muscle strength which involves the movements like sprinting, jumping and shooting [2]. Players improve their game performance by repeated practicing of jumping and shooting during the practice sessions. There are two types of jump performed by the basketball players. Squat jump performed without arm swing and no countermovement and the vertical countermovement jump are performed with arm swing with rapid flexion of hips, knees and ankle joints [3, 4].

Vertical jump height is affected by many anthropometric factors like weight, stature and foot anthropometry [5, 6]. It is considered that individuals with greater stature tend to have a greater vertical jump height. Also, larger weight is thought to produce negative effects on jump performance, decreasing the maximum height [7]. The height achieved during the vertical jump has direct correlation with the amount of force that is produced by the muscle fibers therefore, the greater force produced by the muscle fibers that are involved in the vertical jump is related to a maximum height achieved during jump performance [8].

Lot of researches was done on the factors affecting the jumping height in different-different type of athletes [9]. The foot is one of the most important interaction parts of the body with the ground in upright posture. When the foot works properly it is a powerful aid during jumping, walking or running. Measuring the navicular height is one among the best way to determine the arch height [10-14] and a high arch is potentially able to store more elastic energy in the tendons and fascia during the squatting of the jump in order to use that energy to achieve a greater velocity at the take-off, thus resulting in higher jump [7]. Other factors like foot length and toe length may also influence on jumping height. Longer toes help to stay in contact with the ground longer during take-off, allowing a greater force production [15]. However, a study argues that having shorter toes decreases

the cost of flexing toes during bipedal locomotion and therefore is more beneficial than longer toes [16]. These anthropometric adaptations may help the coach in the basketball training regimen to position the players according to their performance. The relationship between foot anthropometry and jump performance should not be assumed to be similar for both men and women. Taking the above into concern, this study has included only male basketball players and finds the relationship between anthropometric profiles and vertical jump performance in these players.

Materials and method

A correlation study was conducted at K.G Out Patient Department, Saravanampatti. 30 collegiate male basketball players were selected from K.G. Campus based on inclusion and exclusion criteria. The inclusion criteria consisted of male collegiate basketball players between the age group of 18 to 24 years. Whereas players with musculoskeletal injury in lower limb, shoulder and back pain subjects, neuromuscular deficits, peripheral nerve injury, cardiovascular deficits and flat foot were excluded from the study. The players were then explained clearly about the procedure of the study. They were asked to fill in their personal details including name, age, and gender in the form after they agreed to participate in the study. Body Mass Index, foot length, toe length and arch height of the selected players were recorded and they were asked to perform vertical jump test.

Measurements

Body Mass Index

The measuring tape was pasted on the wall and player was asked to stand straight against wall to measure height and the reading was taken at a highest point by pressing down the hair. Three measurements were taken for each player. The body weight measurement was done on electronic weighing machine. The Body Mass Index was calculated by dividing weight (kg)/Height² (meter) and was recorded in documentation.

Foot Length

The player was asked to stand by heel touching the wall and measurement was taken using a measuring tape from heel to longest toe on the foot. The measuring tape was kept on the medial aspect of foot and measurement was recorded in centimeters.

Toe Length

The player was asked to stand with heel touching the wall and measurement was taken from the tip of longest toe to the metatarsophalangeal joint on the dorsal aspect using measuring tape and recorded in centimeters.

Arch Height

The player was asked to sit on chair with feet flat on the ground. The arch height was measured from the medial aspect of the foot from the ground till the highest prominent region of foot using measuring tape in centimeters.

Vertical Jump Test

The player was asked to stand side on to the wall and reach up with the hand closest to the wall. Keeping the feet flat on ground the point o3f fingertip was marked or recorded. This is the standing reach height. The player was then asked to squat and jump as much as possible with the reaching position [17]. The difference in between the standing reach height and jump height is the score. Three attempts were recorded and measurement was done in centimeters.

Statistical analysis

30 players were included in the study on the basis of inclusion and exclusion criteria. All the data were analyzed by using Pearson Correlation. The level of significance set for this study was $p<0.05$

Results

30 players between the age group of 18-24 years were selected for the study based on the inclusion an exclusion criteria of which 3 players belongs to age 18 and 19 each, whereas 5 players of age 20, 8 players of age 21, 7 players belong to age 22, and 2 players each from age group 23 and 24.

Correlating Weight (table 1) and Height (table 2) with Vertical Jumping Height

Table 1 shows that the correlation between Weight and Vertical Jump Height in basketball players by calculating the mean and standard deviation of both. Here, the R value is -0.14 and p value is 0.45. This shows that there is no significant relation between the both. Whereas, table 2 shows the correlation between Height and Vertical Jump Height in basketball players by calculating the mean and standard deviation for both. Here, the R value is 0.06 and p value is 0.73. This shows that there is a significant relation between the both.

Table 1

Variables	Mean	Standard Deviation
Weight	66.83	9.27
Vertical Jump Height	269.03	14.85

Table 2

Variables	Mean	Standard Deviation
Height	177.24	2.86
Vertical Jump Height	269.03	14.85

Correlating Foot Length (table 3), Toe Length (table 4) and Arch Height (table 5) with Vertical Jumping Height

Table 3 shows correlation between Foot Length and Vertical Jump Height in basketball players by calculating the mean and standard deviation of both. Here, the R value is -0.06 and p value is 0.74. This shows that there is no significant relation between the both. The table 4 shows correlation between Toe Length and Vertical Jump Height in basketball players by calculating the mean and standard deviation for both. Here, the R value is 0.47 and p value is 0.07. This shows that there is a significant relation between the both. Table 5 shows correlation between Arch Height and Vertical Jump Height in basketball players by calculating the mean and standard deviation of both. Here, the R value is 0.94 and p value is 0.00001. This shows that there is a strong relation between the both.

Table 3

Variables	Mean	Standard Deviation
Foot Length	24.35	1.87
Vertical Jump Height	269.03	14.85

Table 4

Variables	Mean	Standard Deviation
Toe Length	6.58	0.48
Vertical Jump Height	269.03	14.85

Table 5

Variables	Mean	Standard Deviation
Arch Height	8.04	0.80
Vertical Jump Height	269.03	14.85

Discussion

Around 30 basketball players were selected from KG institutions through convenience sampling method and clear explanation about the procedures were given to each players and then consent form was obtained. The measurement of each variable taken in the study was recorded in each player and they were also asked to perform vertical jump test. In various studies done by other researches, there were a lot of factor contributing to vertical jumping height intrinsically and also extrinsically. Only few studies were done focusing on correlation between foot variables and jumping height. In this study, variable that was being tested included weight, height, foot length, toe length, arch height and vertical jump. Body weight was one of the variables included in the study. In the study, body weight does not have any correlation with the jumping height, p value is 0.7488 which is greater than 0.05. A research was done on gender, height, weight, BMI, waist hip ratio and body fat mass [18]. Among all the factors only body fat mass and gender significantly correlated to jumping height. This showed that the body weight did not significantly correlate with jumping height.

The finding for body height showed that body height had a positive correlation with the jumping height but the result being not significant at $p<0.05$. Greater stature and longer lower length correlate with increased ability to produce anaerobic power, therefore increasing vertical jump height.

This study showed that foot length has a negative correlation with the jumping height, with p value 0.748 which is not significant at $p<0.05$. Also studies suggested that having shorter rear foot bones and longer forefoot bones allow for greater jumping height. The findings of some previous study suggest that the longer forefoot bones are advantageous morphologies for superior performance because of increase in MTP flexor and plantar flexor torques [19]. Also, longer foot may increase the cost of energy for raising heels during the act of jumping.

Although we had hypothesized those shorter toes may provide a better jumping height but toe length had a strong positive relation in the study with p value of 0.008 which is significant at $p<0.05$. During take-off longer toes stay in contact with the ground for a longer duration, this allows for a greater force production and creates a greater acceleration due to ground reaction forces [20].

Arch height also has a strong positive relation with the jumping height with $p<0.00001$. According to the study a higher foot arch results in a higher vertical jump [21]. Foot arch height may help utilize the elastic energy stored by the MTP joint during the stance phase while sprinting [22, 23, 24]. A player with high arch is able to store more elastic energy in the tendons during the squatting portion of a jump in order to use that energy to achieve a greater velocity at takeoff, thus resulting in higher jump. Hence, the foot arch height plays an important role in producing higher plantar flexor torque because of increased MTP joint torque using the stored energy during push-off in the stance phase [25].

Conclusion

This study was done to determine the relationship between foot variables and vertical jump height. Upon analysis this study found that higher body weight has a negative correlation with jumping height as body fat mass may contribute tom a wrong body mass index; whereas a greater stature gives a good jump performance in males. Also, it was found that the foot length had a negative correlation with vertical jump performance in male basketball players as longer foot may increase the cost of energy for raising heels during the act of jumping.

Longer toes allow for more time of contact with the ground, therefore creating a greater acceleration due to ground reaction force. A player with high arch is able to store more elastic energy in the tendons during the squatting portion of a jump in order to use that energy to achieve a greater velocity at take-off, thus resulting in higher jump. These variables may contribute in the selection of position of the players in the game strategy for the better performance in the game. Further, these can also help in providing the coach to train the individual players according to their jump performance in the game.

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Reference

1. Meckel Y, Casorla T, Eliakim A. The influence of basketball dribbling on repeated sprinters. International Journal of Coaching Science,2009:3(2):43-56.
2. Erculj F, Blas M, Bracic M. Physical demands on young elite European female basketball players with special reference to speed, agility, explosive strength and take-off power. J Strength Cond Res, 2010:24(11):2970-2978.
3. Bobbert MF, Casius LJ, Sijpkens I W, Jaspers RT. Humans adjust control to initial squat depth in vertical squat jumping. J Appl Physiol,2008:105(5):1428-40.
4. Chappell JD, Creighton RA, Giulian C, Yu B, Garrett WE. Kinematics and electromyography of landing preparation in vertical stop-jump- risks for non- contact anterior cruciate ligament injury. Am J Sports Med,2007:35(2):235-41.
5. Fattahi A, Ameli M, Sadeghi H. Relationship between anthropometric parameters with vertical jump in male elite volleyball players due to game position. Journal of Human Sports and Exercise,2012:7(3):714-726.
6. Ridha Aouadi, Mc Jid, Riadh Khalifa, Association of anthropometric qualities with vertical jump performance in elite male volleyball players- The Journal of Sports Medicine and Physical Fitness,2020:52(1):11-17.
7. Victoria Sloane Hawley. The relationship between foot anthropometry and jump performance, 2016.
8. Hoffman JR. Performance changes in NBA basketball players vary in starters vs. non-starters over a competitive season, J Strength Cond Res, 2013:27(3):611-615.
9. EA Harman, Michael T Rosensetin. The effects of arms and countermovement on vertical jumping- Medicine

and science of sports and exercise,1990:22(6):825-833.
10. Roth S, Roth A, Jontanovic Z, Mdarevic T. Navicular index for differentiation of flatfoot from normal foot. International Orthopaedics,2013:37(6):1107-1112.
11. Yalcin N, Esen E, Kanatli Uand Yetkin H. Evaluation of the medial longitudinal arch:a comparison between the dynamic plantar pressure measurement system and radiographic analysis. Acta Orthopaedica Et Traumatologica Turcica,2010:44(3):241-245, doi:10.3944/AOTT.2010.2233.
12. Queen R, Mall N, Hardaker W, Nunley J. Describing the medial longitudinal arch using footprint indices and a clinical grading system. Foot and Ankle International,2007:28(4):456-462.
13. Richie D. Biomechanics and clinical analysis of the adult acquired flatfoot. Clinics in Podiatric Medicine and Surgery,2007:24(4):617.
14. Chu W, Lee S, Chu W, Wang T, Lee M. The use of arch index to characterize arch height: a digital image processing approach. Transactions On Bio-Medical Engineering,1995:42(11):1088-1093.
15. Lee S, Piazza S. Built for speed and musculoskeletal structure and sprinting ability- Journal of Experimental Biology,2009:212(22):3700-3707.
16. John W Scott, Campbell Rolian, Lieberman D, Werbel W. Walking, running and evolution of short toes in humans- Journal of Experimental Biology,2009:212(5):713-721.
17. R Dauli, Amit B. Relationship of vertical jump test with anthropometric parameters and body composition in university students- a gender variation- Central European Journal of sports sciences and medicine, 2014:5(1):83-90.
18. Abidin NZ, Adam MB. Prediction of vertical jump height from anthropometric factors in male and female martial arts athletes- The Malaysian Journal of Medical Sciences,2013:2013:20(1):39-45.
19. Calcanues height is a key morphological factor of sprint performance in printers. Tadashi Suga, Msafumi Terada, Tadao Isaba, 2020.
20. Baxter Josh R, Stephen J Piazza. Plantar flexor moment arm and muscle volume predict torque-generating capacity in young men. Jounal of Applied Physiology,2014:1165:538-544.
21. Yuan D. Empirical study on morphology of Wuhu Athlete's foot. Journal of Southwest China Normal University (Natural Science Edition),2013:38(8):61-65.doi:10.13718
22. Mc Donald K A *et al*. The role of arch compression and metatarsophalangeal joint dynamics in modulating plantar fascia strain in running. PLoS ONE 11, e0152602 (2016).
23. Stearne S M *et al*. The foot's arch and the energetics of human locomotion. Sci. Rep.2016,6,19403.
24. Wager J C, Challis J H. Elastic energy within the human plantar aponeurosis contributes to arch shortening during the push-off phase of running. J. Biomech,2016:49:704-709.
25. Morita N *et al*. Toe flexor strength and foot arch height in children. Med. Sci. Sports Exercise.2015:47:350-356.