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Correlation of femoral shaft length and tibia length with the performance of athletes in speed, agility and strength

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Abstract. The objective of this study was to determine whether there is a correlation of femoral shaft length and tibia length with the performance of athletes in speed, agility and strength.
Material and Method. 100 players were volunteered to participate in study which were divided in 5 groups of 20 athletes each of 5 groups of different sports. Each athlete was tested for his performance in speed by 30m dash test, in agility by Quadrant jump test and his lower limb strength by triple hop distance. *Result.* There was a correlation of femoral shaft length with the performance in speed but there was no correlation of with the performance in agility and strength. There was no correlation of tibia length with any of the performances either.
Conclusion. The performance of athlete cannot be determined by only evaluating him by his height or body segment length. There are many other factors which play major roles in deciding his performance.
Key words: *speed, agility, strength, performance, correlation.*

Introduction

Human variation is a biological fact. This is strikingly apparent in different Sports where event selectivity reflects concomitant genetic and environmental influences on physique (1).
Apart from physiological parameters, several anthropometric parameters show an association with endurance performance such as body mass, body mass index (BMI), body fat, length of the upper leg, length of limbs, body height, circumference of thigh, total skin-fold thickness, and skin-fold thickness of the lower limb (2). These various anthropometric factors have different effects in different sports disciplines and distances (3).
The runners were observed to be more linear than swimmers since their proportional arm, thigh and tibia lengths were larger than swimmers (4). It was pointed out by Tanner[5] that there is increased leg length in middle distance runners as compared to sprinters and distance runners. Long distance runners were proportionally shorter in thigh and tibia length. The long jumpers, were proportiona - lly longer in thighs than the sprinters (4). The Throwers in comparison to sprinters had shorter thighs (4).
The purpose of this study is to gain a better understanding as to whether or not physical stature particularly the lower limb differences are somewhat in relation to the sports specificity.

Material and Methods

A sample of 100 healthy athletes (n=100) of age 18-26 years were selected by enrolling 20 players each from running, hockey, basketball, football and lawn tennis.
All the subjects were informed about the nature, purpose, and possible risk involved in the study and an informed written consent signed by them, was taken from them prior to participation. The athletes were selected on the basis of inclusion and exclusion criteria. This study has been successfully approved by the Ethical Committee of Jamia Hamdard University, Delhi, India. Each group had 20 participants each.

The mean age of the participants in Group I (runners) was 19.95 ± 2.82ys, mean height was 167.63 ± 5.72cm, mean weight was 61.17 ± 6.51kg and mean BMI was 21.80 ± 1.94kg/m^2. The mean age of the participants in Group II (hockey players) was 19.35 ± 1.95ys, mean height was 170.67 ± 6.58cm, mean weight was 64.50 ± 6.65kg and mean BMI was 22.76 ± 3.77 kg/m^2. The mean age of the participants in Group III (basketball players) was 21.00 ± 2.40ys, mean height was 175.48 ± 12.99cm, mean weight was 73.35 ± 8.97kg and mean BMI was 23.93 ± 1.74 kg/m^2. The mean age of the participants in Group IV (football players) was 19.25 ± 1.21ys, mean height was 173.65 ± 10.19cm, mean weight was 64.00 ± 5.82kg and mean BMI was 21.56 ± 3.27 kg/m^2. The mean age of the participants in Group V (lawn tennis players) was 21.1 ± 2.94ys, mean height was 172.65 ± 9.26cm, mean weight was 63.75 ± 7.25kg and mean BMI was 21.60 ± 1.86 kg/m^2.

Procedure. A total of 100 players were selected, 20 each from hockey, basketball, football, lawn tennis and runners. Out of the players, who were volunteered assigned for the study, 20 were selected randomly according to the inclusion and exclusion criteria in each sport. The femoral shaft length and the tibia length of all the players were measured and the strength, speed and agility of the players were measured using Triple Hop Distance, 30m Dash and Quadrant Jump test respectively. Inclusion Criteria: healthy individuals voluntarily participating in the study age between 18-26 years; free from any injury in the lower limb & spine; no pain in the lower extremities and back while running or weight bearing exercises; individuals participating in their respective sports from at least last 6months. Exclusion Criteria; acute or chronic back pain; any obvious deformity in the lower extremity including leg length discrepancy on observation only; abnormal gait.

Measurements. The measurement for femoral shaft length was taken from the greater trochanter to the lateral femoral epicondyle (6). The tibia length was measured by taking distance from the tibial medial condyle to the medial malleolus (7).

30m Dash Test - The athletes were asked to run a single maximum sprint over 30 meters, with the time recorded. The athlete started from a stationary position, with one foot in front of the other. The front foot must be on or behind the starting line. The athlete was provided with hints for maximizing speed (such as keeping low, driving hard with the arms and legs) and was encouraged to continue running hard through the finish line. Two trials were allowed, and the best time was recorded to the nearest 2 decimal places. The timing starts from the first movement (if using a stopwatch) or when the timing system was triggered, and finishes when the chest crosses the finish line (8).

Quadrant Jump Test - This is a not a running type agility test, measuring the ability to move around in a small space with maximum speed, while maintaining balance and control (coordination). A quadrant was marked out on the floor. The starting line was marked and numbers were given to each quadrant. The subject stands with both feet together at the starting line. On the command 'go', they jumped ahead across the line into the first quadrant, then in sequence successively into quadrants 1, 2, 3, 4, 1, 2, etc. This pattern was continued as rapidly as possible for 10 seconds. After a rest the trial was repeated. The best score from two, 10 second trials was the subject's score. The subject's score was the number of correct jumps less a penalty deduction. One point was awarded each time the subject lands with both feet entirely within the correct quadrant during the 10 second trial, with a penalty of 0.5 point subtracted each time the subject touches a line and for each time the subject lands with one or both feet in an incorrect quadrant (9).

Triple Hop Distance (10-12) - To perform the test, the athletes executed three consecutive forward hops using their dominant leg. The objective was to cover maximum distance after three consecutive hops. The athletes started with their toe just touching a starting line and had been told to hop three times while maintaining their balance. Swinging the arms was acceptable and the only movement not allowed was touching the ground with anything other than the hopping foot. The final distance was measured from the starting line to the back of the heel after the third and final hop.

Statistical analysis. The data was statistically analyzed by using Statistical Package for Social Science (SPSS-20) software system. The Karl Pearson product-moment correlation was used to determine the relation between selected variables, $p<0.05$ was considered significant.

Results and discussion

The following results were obtained: Height 172.02 (9.52) cm; FSL 42.03 (3.14) cm; TBL 40.67 (2.63) cm.

The height of athletes correlated with their FSL and TBL at the significant level of 0.01. In runners, femoral shaft length correlates positively with their performance in speed. Also femoral Shaft length correlates with the 30m dash time when the combined data of all the athletes taken together from all groups (p= 0.247; r=0.013). Femoral shaft length is not correlated with any other performance. Also there is no correlation observed between tibia length and performance of athletes in speed, agility and strength.

The results of the present study show that FSL of runners and the speed have moderately strong correlation. Results show that the time of 30m dash decreases with the increase in femoral shaft length of the runners. It has been reported by Ishiwata & Oosawa **(**1974) that increasing sarcomere length may decrease the distance between the filaments and so enhance force production (13).

Multiple studies have shown that faster athletes muscle fiber shortening velocity may be a reasonable parameter for the determination of sprint running performance. Several studies (14, 15) have demonstrated that elite male sprinters have a high percentage of fast-twitch muscle fibers in leg muscles and that maximum running speed is significantly correlated with percentage of fast-twitch fibers (16). But in case of tibia the reason for this could be that the plantar-flexor moment arms are 25% smaller in sprinters than in non-sprinter (17,18,19). So, whatever advantage is gained by the increased, tibia length may have been nullified by the decrease in moment arm of the plantar-flexors.

In the present study the results show that there was no correlation of FSL and TL with agility respectively.

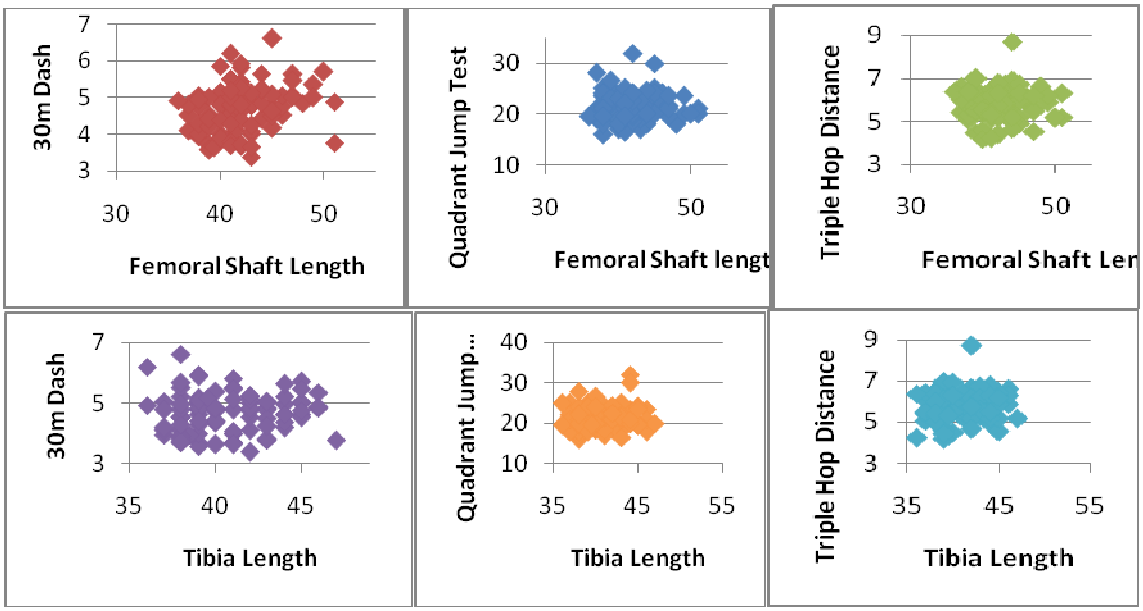

Figure 1. Correlations of FSL and TBL with the performances in 30m Dash test, Quadrant jump test and Triple hop distance

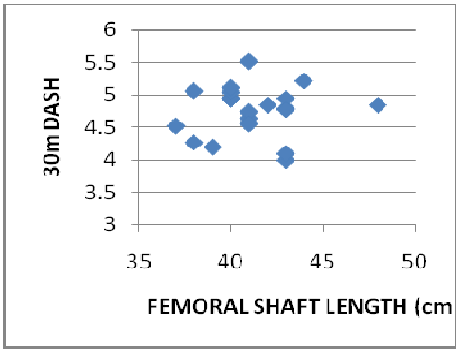

Figure 2. Correlation of FSL with 30m Dash

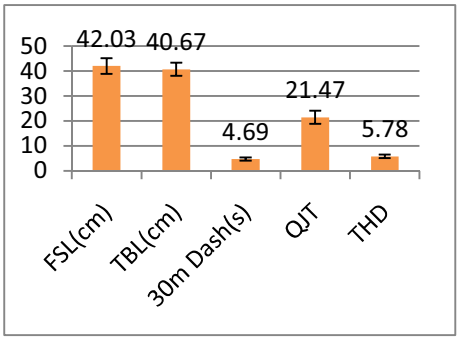

Figure 3. Descriptive analysis for variables in runners

Table I. Descriptive analysis for Femoral Shaft Length (FSL), Tibia Length, 30m Dash test, Quadrant Jump Test (QJT) and Triple Hop Distance (THD)

Variable	Total Mean ± S.D	Range
Femoral Shaft Length (cm)	42.03 ± 3.14	36 - 51
Tibia Length (cm)	40.67 ± 2.63	36 - 47
30m Dash Test	4.69 ± 0.64	3.38 – 6.62
Quadrant Jump Test	21.47 ± 2.62	16 – 32
Triple Hop Distance	5.78 ± .67	4.17 – 8.70

Rooney (2005) indicates the following motor characteristics are the basis of agility: relative strength (compared to the athletes body mass), linear speed, motor coordination (timing), balance (stability) and motor programs (technique) (21). The poor influence of anthropometric parameters on rapid movement tests results was determined in other studies (21- 24) The coordination does not depend of anthropometric parameters such as height and length of body segments (24) There was no correlation between the FSL and Speed, Agility and strength performances of hockey players, basketball players, football players and lawn tennis players respectively.

Also there was no correlation between tibia length and speed, agility and strength performance respectively of hockey players, basketball players, football players and lawn tennis players. The reason for these could be the same as stated above.

There was a correlation between the FSL and the 30m Dash time, the latter getting increased with increase in femoral shaft length. Therefore, the FSL is said to be positively correlated with the 30m dash time and negatively correlated with the performance in speed. When results were observed for other groups, there was no correlation of femoral shaft length of hockey, basketball, football and lawn tennis players with the performance in speed except runners. The reason for this may be that many other factors, such as body mass, fat mass, weight, age, subcutaneous fat, acceleration, reaction time, stride length also may play a much larger role. These may be the reasons that why femoral shaft length show negative correlation with the speed performance when all the athletes taken together. Also the tibia length is not correlated with any of the performance tests in all groups.

This supports the result of this present study that femoral shaft length and tibia length separately may not be able to determine the performance in agility. When all sports taken together, the results show that the femoral shaft length and the speed have moderate correlation.

Conclusions

On the basis of the results of this study we can conclude that, overall the femoral shaft length and tibia length which in turn determine the height of an individual have no correlation with the performance in speed, agility and strength. Rather, increased femoral shaft length (height of individual) may have a negative influence on the performance in speed, if all the other factors which are responsible for speed performance are not taken care of. Increased bone length per se may decrease the speed performance of an individual.

Limitation of the study: conventional measuring tape was used; only male subjects were included in the study; none of the international level athletes were included; the athletes of age group 18-26 only were included.

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