

Morphological Characteristics and Explosive Power of Athlete and Non-Athlete

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Objectives: The aim of this study was to identify the effect of morphological characteristics i.e. somatotype and body composition variables on explosive power of college level men students. **Methods:** For this purpose 500 young college students were selected and divided into two equal groups: athletes undergoing Bachelor of Physical Education course (n= 250) aged 23.86 ± 0.36 years; and non-athletes, college students do not take part regular physical activities (n=250) aged 22.16 ± 0.88 years. The somatotype was assessed using the Heath & Carter method. Assessing body composition of the subject various anthropometric measurements were taken. Sargent vertical jump test was used to assess leg explosive power. The measures were compared between the two groups using the Student t-test for independent samples. **Results:** The two groups differed significantly in terms of body weight, % body fat, lean body mass, % skeletal muscle mass and somatotype. The vertical jump was positively significantly correlated with % skeletal muscle mass, lean body mass, mesomorphy and ectomorphy components of somatotype; on the other hand body weight, height, % body fat, body surface area and endomorphy component of somatotype significantly negatively correlated. **Conclusions:** It may be concluded that, somatotype and body composition variables are important factors in determining leg explosive power.

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Key Words: Somatotype, vertical jump; % body fat; lean body mass

INTRODUCTION

Morphological characteristics (i.e. somatotype and body composition) have an important role to play in the performance of various physical activities. Somatotyping has a relatively long tradition in human biology. Since the early development of Sheldon's somatotyping system, researchers have studied the relation of somatotype and body composition to physical performance (1). About 25% to 65% of the variance in physical fitness tests could be explained by somatotype in adult sportsmen (2,3). Power is the product of force applied on the athlete and the velocity of the athlete (4,5). The best way to test the explosive power is to find how much of C.G can be raised in standing jump. This can be determined by measuring the difference between a person's jumping reach and his standing reach, with his arm fully extended upward. Vertical jump is commonly used as an index for the power of the lower limb or explosive leg power

(6-9). Vertical jumping ability is an important fundamental skill for many athletic activities. Vertical jump height is a measurement that coaches, health care professionals, and strength and conditioning professionals frequently use (10) as an objective functional measurement. Many coaches consider vertical jump as an essential skill contributing to higher performance in numerous sports, including football, basketball, diving, and volleyball (11,12). Some authors consider vertical jump performance a measurement of muscular power of the lower extremity (13-15), whereas others see the vertical jump as a measurable coordinated activity (16-20). Vertical jump is a frequently assessed athletic skill used to measure improvement of an athlete's capabilities throughout a specific training program (21).

The performance of the athlete in the vertical jump is closely related to biomechanics. Velocity, force, acceleration and momentum are the biomechanical

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principles involved in any type of vertical jump (22,23). Apart from the biomechanical and physiological factors, anthropometric and body composition characteristics also play significant roles in vertical jump performance. Studies on anthropometric and body composition characteristics have been carried out by a number of researchers (5,16,21,24-28). However, only a few studies on the performance of college level students in vertical jump have ever been published. Therefore, the objective of this article was to determine the influence of somatotype and body composition characteristics on vertical jumping ability. The other aim was to compare vertical jump performance in young athlete and non-athlete of college students.

MATERIAL AND METHODS

The present study was conducted on 250 athletes and 250 non-athletes (total 500) young college levels male students (age range 18-25 years & mean age 22.16 ± 0.88). Athletes were completed one year Bachelor of Physical Education (B.P.Ed) course and took part in obligatory physical activities under their course of study and non-athlete students were not participated regular physical activity. The subjects were selected from nineteen colleges located in nine different districts of West-Bengal in India irrespective of their caste, religion, dietary habits and socio-economic status. The age of the subjects were calculated from the date of birth as recorded in their institution. The investigation received ethical approval from the Visva Bharati University Research Degrees Ethics Committee.

The anthropometric measurements were carried out using standard instruments and in accordance with the methodology recommended by the International Society for the Advancement of Kinanthropometry (Ross & Marfell-Jones, 1991). All the anthropometrics measurements of the subjects were taken right side of the body as per the direction of the Leon and The Koerner Foundation Study Group in 1973. Researcher was used the technical error of measurement (TEM) for evaluating the consistency, or precision, of the measure on a given variable. The TEM is the square root of the sum of the differences between measures one and two squared, divided by twice the number of subjects. The TEM provides an estimate of the measurement error that is in the units of measurement of the variable. The TEM was lower than 2% for skinfolds and 0.5% for the other measurements.

The response variable was the vertical jump; the explanatory variables were height, weight, corrected thigh girth (thigh skinfold subtract from thigh girth), corrected calf girth (arm skinfold subtract from arm

girth), % body fat, lean body mass, % skeletal muscle mass, % skeletal mass, body surface area and somatotype components (endomorph, mesomorph, ectomorph). The height was measured to the nearest 0.1 cm using a stadiometer. The subjects wore light clothing and were weighted to the nearest 0.1 kg using a calibrated digital scale. Researcher also examine five muscle girths (upper arm, fore arm, chest, thigh and calf) in cm, four bone diameters (humerus, bistyloid, femur and bimalleolus) in cm, and eight skinfolds thickness (triceps, sub-scapular, suprailiac, pectoral, axilla, abdominal, thigh and calf) in mm. For calculating body density of the subjects Jackson and Pollock (29) equation was adopted. The Siri Equation (30) was used to convert body density to percent body fat of each participant. Poortman's (31) and Drinkwater et al. (32) formula was taken up for assessing skeletal muscle mass and skeletal mass respectively. Measurement of body surface area (BSA) of the subjects Mosteller's Formula (33) was used. Somatotype components (endomorph, mesomorph and ectomorph) of the subjects were calculated according to Carter and Heath anthropometric method (34). Lastly, for explosive power Sargent vertical jump test was conducted. First, confidence of appropriate physical condition were achieved, correct process of measurement were described for them and then subjects warmed up completely to perform the test. Subject stands side on to a wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. This is called the standing reach height. The athlete then stands away from the wall, and jumps vertically as high as possible using both arms and legs to assist in projecting the body upwards. Attempt to touch the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height is the score. The best of three attempts was recorded in cm.

Statistical Analysis

Descriptive statistics (mean, \pm standard deviation) and Student t-test for independent samples were used for compared between the athletes and non-athletes. Pearson's correlation of coefficients was used to establish the correlations of vertical jump with other variables in athletes and non-athletes of college level students. Data were analyzed using SPSS (Statistical Package for Social Science) version 17.0. A 1% level of probability was used to indicate statistical significance.

RESULTS

Table 1 depicts the mean and standard deviation of the variables of athlete and non-athlete. The mean height
Table 1. Descriptive statistics and t-value of body composition, somatotype and leg explosive power of athlete and non-athlete

| Variables | Athlete | | Non-Athlete | | t-Value | |
|------------------------------------|-------------------------------------|--------|-------------|--------|---------|---------|
| | Mean | S.D. | Mean | S.D. | | |
| Anthropometric Measurements | Height (cm) | 168.82 | 5.63 | 168.33 | 5.59 | 0.97 |
| | Weight (kg) | 60.44 | 5.53 | 58.43 | 6.48 | 3.71** |
| | Corrected Thigh Girth (cm) | 49.32 | 2.97 | 47.22 | 3.91 | 9.54** |
| | Corrected Calf Girth (cm) | 32.52 | 1.84 | 30.02 | 2.31 | 18.89** |
| | % Body Fat | 12.37 | 3.01 | 14.36 | 3.69 | 6.58** |
| Body Composition | % Skeletal Mass | 13.57 | 1.34 | 13.38 | 0.98 | 1.80 |
| | % Skeletal Muscle Mass | 49.79 | 3.22 | 40.35 | 3.32 | 4.90** |
| | Lean Body Mass | 52.90 | 4.55 | 49.95 | 5.23 | 6.70** |
| | Body Surface Area (m ²) | 1.68 | 0.09 | 1.65 | 0.10 | 3.51** |
| Somatotype | Endomorphy | 2.86 | 0.86 | 4.87 | 1.01 | 6.17** |
| | Mesomorphy | 4.67 | 0.88 | 3.44 | 1.23 | 5.51** |
| | Ectomorphy | 3.85 | 0.74 | 3.34 | 1.18 | 5.42** |
| Explosive Power | Vertical Jump (cm) | 49.13 | 6.87 | 42.41 | 6.43 | 11.24** |

(**) indicates p< 0.01.

Table 2. Pearson correlation of body composition and somatotype with leg explosive power of athlete and non-athlete

| Variables | Athlete | Non-Athlete |
|-------------------------------------|----------|-------------|
| Height (cm) | -0.432** | -0.291** |
| Weight (Kg) | -0.279** | -0.175** |
| Corrected Thigh Girth (cm) | 0.531** | 0.598** |
| Corrected Calf Girth (cm) | 0.419** | 0.244** |
| % Body Fat | -0.454** | -0.531** |
| % Skeletal Muscle Mass | 0.285** | 0.312** |
| % Skeletal Mass | 0.351** | 0.363** |
| Lean Body Mass (kg) | 0.527** | 0.412** |
| Body Surface Area (m ²) | -0.339** | -0.226** |
| Endomorphy | -0.448** | -0.508** |
| Mesomorphy | 0.518** | 0.426** |
| Ectomorphy | 0.329** | 0.248** |

(**) indicates p< 0.01.

of the selected athlete and non-athlete is parallel, which are 168.82 ± 5.63 cm and 168.33 ± 5.59 cm

respectively. Although athletes have higher mean body weight (60.44 ± 5.53 kg) than non-athletes do (58.43 ± 6.48 kg), but they have lower mean % body fat (12.37 ± 3.01 %) than non-athletes (14.36 ± 3.69 %). Athletes have higher mean corrected thigh girth (49.32 ± 2.97 cm) and mean corrected calf girth (32.52 ± 1.84 cm), as well as greater mean % skeletal muscle mass (49.79 ± 3.22 %), % skeletal mass (13.57 ± 1.34 %), lean body mass (52.90 ± 4.55 kg), body surface area (1.68 ± 0.09 m²), mesomorphy component (4.67 ± 0.88) and mean vertical jumping ability (49.13 ± 6.87 cm). In contrast, the mean value for corrected thigh girth, corrected calf girth, % skeletal muscle mass, % skeletal mass, lean body mass, body surface area, mesomorphy component, and mean vertical jumping ability of non-athletes are 47.22 ± 3.91 cm, 30.02 ± 2.31 cm, 40.35 ± 3.32 %, 13.38 ± 0.98 %, 49.95 ± 5.23 kg, 1.65 ± 0.10 m², 3.44 ± 1.23 and 42.41 ± 6.43 cm respectively. Pearson coefficient of correlation of body composition variables and somatotype components with vertical jumping ability was

presented in Table 2. All the variables were statistically either positively or negatively significant correlation at 0.01 level with vertical jumping ability irrespective of athlete or non-athlete.

DISCUSSION

The purpose of this study was to determine the effects of somatotype and body composition factors on vertical jump height among college level athletes and non-athletes students. The finding of the present study is similar to the work done by Ostojic et al (35), they demonstrated the height and weight of a player had significantly negative correlation with vertical jump height. This result is disagreed by Aslan et al. (25) and Davis et al. (26) where they reported that there is no significant relationship between vertical jump and body height and weight. Greater thigh and calf girth has significant positive correlation with vertical jump in athletes and non-athletes. Muscle size effects force producing and jump performance. Perhaps, greater physiological cross section of muscles, contains more sarcomers contributing in muscular contractile which leads to more cross bridges foundation and finally greater force production.

Body fat % is the amount of body fat stored in the body and does not take into account the lean body mass and muscle mass. Table 2 shows that body fat % and vertical jump have a negative association. An individual with lower body fat % definitely has a higher vertical jump (16,24). This is because the athletes with lower body fat % and greater power are more likely to generate greater velocity of kicking (5). The study done by Davis et al. (26) has reported that body fat % is the best predictor of vertical jump for recreational male athletes aged between 20 to 37 years old. This result corresponds to that of Roschel et al. (5), who stated that the sum of skinfold thickness has significant negative association with vertical jump height. Body fat % is related to the work performed during vertical jump. Since work is the product of average force acting on the subject and the displacement of the jump, heavier athletes need more work to move the body to the same displacement achieved by lighter athletes (5,11). So, in order to perform better, the coaches and dieticians should have guided the athletes to burn the body fat with proper training and dietary planning. Food consumption should be monitored so that the body fat will be flushed away without losing the nutrition.

In present study the mean somatotype of the college level athletes is ectomorphic mesomorph (2.86-4.67-3.85) on the other hand mean somatotype of non-athlete students is balanced endomorph (4.87-3.44-

3.34). A higher mesomorphic rating in athletes than the non-athlete college level students suggests that the former are more muscular than the later (Table 1). High mesomorphic ratings in athletes can be attributed to take part in obligatory physical activities under their course of study, as there is positive association between mesomorphic component and physical activity (36,37). Mesomorphy and ectomorphy components of somatotype are significantly positive correlated with vertical jumping ability (38), where as endomorphy component found significantly negative correlation with vertical jump.

CONCLUSIONS

The vertical jump for Indian college level male athletes is significantly higher than that of their non-athlete counterparts. Body weight, corrected thigh girth, corrected calf girth, % skeletal muscle mass, lean body mass and mesomorphy component of somatotype is significantly positive association to the vertical jump height of Indian college level male athletes and non-athletes. In contrast, body fat % is an important body composition factor that has a significant negative relationship with vertical jump height of Indian college level male students irrespective of athlete and non-athlete. Reducing the amount of body fat with proper physical training and dietary planning will be helpful to improve the leg power.

REFERENCES

1. Raudsepp L, Jurimae T. Somatotype and physical fitness of prepubertal children. *Collegium Antropologicum* 1996; 20(1):53-59.
2. Laubach L, McConville J. The relationship of strength to body size and typology. *Medicine and Science in Sports* 1969; 1(4):189-194.
3. Malina RM. Anthropometric correlates of strength and motor performance. *Exercise and Sports Sciences Review* 1975; 3:249-274.
4. Reiser RF, Rocheford EC, Armstrong CJ. Building a better understanding of basic mechanical principles through analysis of the vertical jump. *Strength Cond J* 2006; 28(4):70-80.
5. Roschel H, Batista M, Monteiro R, Bertuzzi RC, Barroso R, Loturco I. Association between neuromuscular tests and kumite performance on the brazilian karate national team. *J Sports Sci Med* 2009; 8(3):20-24.
6. Chu DA. Explosive power & strength. Champaign, IL: Human Kinetics, 1996.
7. Moir G, Button C, Glaister M, Stone M. Influence of familiarization on reliability of vertical jump and acceleration sprinting performance in physically active men. *J Strength Cond Res* 2004; 18(2):276-280.
8. Richards DK. A two-factor theory of the warm-up effect in jumping performance. *Res Q* 1968; 39:668-673.
9. Shellock FG, Prentice WE. Warming-up and stretching for improved physical performance and prevention of sports-related injuries. *Sports Med* 1985; 2:267-278.

10. Waggener GT, Barfield WR, Sessoms ED. Prediction of maximal vertical jump height, revisited. *Int Sports J* 2002; 6:107.
11. Baker D. Improving vertical jump performance through general, special, and specific strength training: A brief review. *J Strength Cond Res* 1996; 10:131-136.
12. Klavora P. Vertical jump test: A critical review. *Strength Cond J* 2000; 22(5):70-74.
13. Liebermann DG, Katz L. On the assessment of lower limb muscular power capability. *Isokinetics Exerc Sci* 2003; 11:87-94.
14. Patterson DD, Peterson DF. Vertical jump and leg power norms for young adults. *Meas Phys Educ Exer Sci* 2004; 8(1):33-41.
15. Tricoli V, Lamas L, Carnevale R, Ugrinowitsch C. Short-term effects on lower body functional power development: Weightlifting vs. vertical jump training programs. *J Strength Cond Res* 2005; 19:433-437.
16. Noorul HR, Pieter W, Erie ZZ. Physical fitness of recreational adolescent taekwondo athletes. *Braz J Biomotricity*. 2008; 2(4):230-240.
17. Myer GD, Ford KR, Palumbo JP, Hewett TE. Neuromuscular training improves performance and lower extremity biomechanics in female athletes. *J Strength Cond Res* 2005; 19:51-60.
18. Tomioka M, Owings TM, Grabiner MD. Lower extremity strength and coordination are independent contributors to maximum vertical jump height. *J Appl Biomech* 2001; 17:181-187.
19. Eloranta V. Influence of sports background on leg muscle coordination in vertical jumps. *Electromyogr Clin Neurophysiol* 2003; 43:141-156.
20. Greenberger HB, Paterno MV. Relationship of knee extensor strength and hopping test performance in the assessment of lower extremity function. *J Orthop Sports Phys Ther* 1995; 22:202-206.
21. Markovic G, Jaric S. Is Vertical jump height a body size-independent measure of muscle power? *J Sport Sci* 2007; 25(12):1355-1363.
22. Bobbet MF, Van Soest AJ. Effects of muscle strengthening on vertical jump: A simulation study. *Med Sci Sports Exerc* 1994; 26(8):1012-1020.
23. Kroon S. Vertical jump ability of elite volleyball players compared to elite athletes in other team sports. 2000. Available from: [http:// www.Faccioni.com/reviews](http://www.Faccioni.com/reviews).
24. Dizon JMR, Grimmer-Somers K. Making Filipino Taekwondo athletes internationally competitive: an international comparison of anthropometric and physiologic characteristics. *J Sport Medic Doping Studies*. 2012; 2(1):105-111.
25. Aslan CS, Koc H, Aslan M, Ozer U. The Effect of Height on the Anaerobic Power of Sub-Elite Athletes. *World Applied Science Journal* 2011; 12(2):208-211.
26. Davis DS, Briscoe DA, Markowski CT, Saville SE, Taylor CJ. Physical characteristics that predict vertical jump performance in recreational male athletes. *Phys Ther Sport* 2003; 4(4):167-174.
27. Wyon M, Allen N, Angioi M, Nevill A, Twitchett E. Anthropometric factors affecting vertical jump height in ballet dancers. *J Dance Med Sci* 2006; 10(3&4):106-110.
28. Reeves RA, Hicks OD, Navalta JW. The relationship between upper arm anthropometrical measures and vertical jump displacement. *Int J Exerc Sci* 2008; 1(1):22-29.
29. Jackson AS, Pollock ML. Generalized equations for prediction body density of men. *Br J Nutr* 1978; 40:497-504.
30. Siri WE. Gross composition of the body. in: advances in biological and medical physics (Vol. IV). Lawrence, JH, and Tobias, CA, eds. New York: Academic Press, 1956.
31. Poortmans JR, Boisseau N, Moraine JJ, Moreno-Reyes R, Goldman S. Estimation of total body skeletal muscle mass in children and adolescents. *Med Sci Sports Exerc* 2005; 37(2):316-322.
32. Drinkwater BL, Nilson K, Chesnut CH, Bremner WJ, Shainholtz S, Southworth MB. Bone Mineral Content of Amenorrheic and Eumenorrheic Athletes. *N Engl J Med* 1984; 311:277-281.
33. Mosteller RD. Simplified calculation of body surface area. *N Eng J Med* 1987; 317: 1098.
34. Carter L, Heath B. Somatotyping. Development and applications. Cambridge: University Press, New York; 1990.
35. Ostojic SM, Mazic S, Dikic N. Profiling in basketball: Physical and physiological characteristics of elite players. *J Strength Cond Research* 2006; 20(4):740-744.
36. Malina RM, Geithner CA. Body composition of young athletes. *Am J Lifestyle Med* 2011; 5:262-278.
37. Ozener B, Duyar I. The effect of labour on somatotype of males during the adolescent growth period. *J Comp Hum Biol* 2008; 59(2):161-172.
38. Joanna L, Krzysztof B, Anna P, Katarzyna B. Somatotype variables related to muscle torque and power in judoists. *Journal of Human Kinetics* 2011; 30:21-28.