Selected Motor Variables and Anthropometric Characteristics as a Predictor of Hundred Meter Sprint Performance

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Abstract

Purpose The purpose of this study was to investigate the motor variables and anthropometric characteristics as a predictor of hundred meter sprint performance of college athletes. Method 30 male 100m sprinters were randomly selected from various colleges during intercollegiate athletics tournament 2011-12 which was organized by CSJM University, Kanpur in university sports stadium. The age of the subjects ranged between 19-23 years. A multiple regression was used at $p \leq 0.05$ alpha level with motor (explosive leg strength, agility, reaction time and flexibility) and anthropometric (sitting height, standing height, body weight, chest girth, arm length, leg length) characteristics (independent variables) as to predict hundred metre sprint performance (dependent variable). Results R^2 of 4.819 indicating that the model has approximately accounted 48.19 % variability. Although significant correlation were found of the anthropometric variables i.e. sitting height (0.17), standing height (0.47), body weight (0.47), chest circumference (0.41), arm length (0.60) and leg length (0.77) values and motor variables i.e. explosive strength (0.74), agility (0.46) and reaction time (0.73) values with hundred metre sprinting performance. Sitting height (0.17) and flexibility (0.30) were found insignificant relationship with sprinting performance at 0.05 level of significance. Conclusions Study suggested that (1) selected motor variables and anthropometric characteristics may enhance the sprinting performance (2) all correlated variable having 48.19% contribution in sprinting performance.

KEYWORDS- Sprinting performance, Anthropometric characteristics, Motor variables

Introduction

Many characteristics of the human body play major roles in the action of sprinting. The apparently simple skill of sprinting is actually dependent on an "athlete's ability to combine the actions of legs, arms, trunk and so on into smoothly coordinated whole" (Hay, 1993). We have to consider aspects of human anatomy, such as body height, stride frequency, stride length, speed, energy production, somatotype, anthropometry, power and muscle fibre composition, when analysing such an event. We would also consider external contributing factors such as footwear, sate of fatigue, injury history, the running surface and variation in horizontal forces (Hall, 1999).The most important need of young Indian athlete now a days is the scientific training programmes specially based on age, physical fitness, motor ability, psychological and cardiovascular levels according to various norms of Indian population. These types of training programmes may be helpful in the popularisation of sports. Due to popularisation of sports in India, there will be a lot of improvement in physical standards and mental health of the mass (Khetarpal 1989). World of sports is repeated with different methods of testing, measuring and prescribing exercise on the basic of motor qualities such as strength, speed, flexibility and power and metabolic or physiological qualities such as 'aerobic' (cardiovascular) and 'anaerobic' fitness. These qualities are usually regarded as the fundamental components of the situation-specific quality known as 'fitness' yet their validity and discreteness is rarely questioned (Dougall et al., 2003). Anthropometry is the science that deals with measurements of size, weight and proportions of human body. It provides scientific methods and observations on the living humans. Anthropometric techniques (skinfold fat, circumference and diameter measurements) are popular for predicting body composition because they are not much expensive, require little space and can be performed easily (Behenke and Willmore, 1974 and Pollock and Willmore, 1990). Dintiman et al. (1997) concluded that athletes possessing shorter legs seem to have an advantage over an athletes with long legs. The shorter leg is more suited to sprints as having a lower point of inertia- it is easier to move than a long leg. This is not to say that short legs and speed are directly associated, but when the powerful muscles combine with a lower point of inertia, the result is a faster stride rate (even though stride length may be slightly reduced). Anthropometric characteristics typical of world-class sprinters might be explained, in part, by the influence the anthropometric characteristics have on relative muscle strength and stride length (UthNiels, 2005).

Methods

Experimental protocol

100 meter sprint performance were measured with the help of stop watch. Testing was conducted on a grass tract in evening session. Before testing, subjects were allowed to perform an adequate standardized warming up, which included slow running, high knee jumping, trenching and light jumping exercises.

Subjects

Thirty (30) college male hundred metre sprinters were randomly selected from different colleges during the intercollegiate athletics tournament 2011-12 organized by CSJM University, Kanpur (India) in university sports stadium. The age range of the subjects 19-23 years.

Procedures

The anthropometric kit was provided by Department of Physical Education, CSJM University, which was supplied by Desco Medical India, Pvt Ltd.

Criterion Measures

Table 1 Anthropometric Measurement of subjects

Anthropometric Variables	Test	Measurement in
Sitting Height	Stadio Metre	Centimetre
Standing Height	Stadio Metre	Centimetre
Body Weight	Weighing Machine	Centimetre
Chest Girth	Steel Tape	Centimetre
Arm Girth	Steel Tape	Centimetre
Arm Length	Steel Tape	Centimetre
Leg Length	Steel Tape	Centimetre

Table 2 Motor Variables of the subjects

Motor Variables	Test	Measurement
Explosive Leg Strength	Standing Broad Jump	In Meter
Agility	10×4 M Shuttle Run	In Seconds
Reaction Time	Stop Watch	In Seconds
Flexibility	Sit and Reach Test	In Centimetre

Statistical analysis

Statistical methods were used for the calculation of mean and standard deviation (SD). Statistical analyses was carried out on MS-Excel 2013. Pearson correlation coefficients (r) were calculated to establish the relationships between sprint parameters and both anthropometric and motor variables parameters. Regression analysis was used to predict the performance of sprinters. Statistical significance was determined using a probability level of $p \leq 0.05$.

Results

Motor variables and anthropometric characteristics values of the research group and other findings in the study are presented in the following tables.

Table 3 Descriptive statistics motor and anthropometric variables

Variables	Mean	SD	Range	Min	Max
Body Weight (Kg)	55.20	3.22	19	46	65
Chest Circumference (cm)	80.00	4.54	13	74	87
Arm Girth(cm)	28.15	2.81	8	24	32
Arm Length(cm)	70.80	3.22	12	64	76
Leg Length(cm)	97.75	5.41	17	87	104
Speed(sec)	6.97	0.83	2.15	6.22	8.37
Explosive Leg Strength	2.29	0.47	1.51	1.34	2.85
Agility	9.98	0.96	2.85	8.52	11.37
Flexibility	23.30	4.69	13	18	31
Reaction Time	12.85	2.47	11.51	6.24	17.75
100 mts Sprint Performance	12.71	1.21	3.80	11.20	15.00

Table 3shows that the mean and standard deviation of the anthropometric variable of hundred meter sprinters i.e. body weight (55.20 ± 3.22), chest circumference (80.00 ± 4.54), arm girth (28.15 ± 2.81), arm length (70.80 ± 3.22), leg length (97.75 ± 5.41) and motor variables i.e. speed (6.97 ± 0.83), explosive leg strength (2.29 ± 0.47), agility (9.98 ± 0.96), flexibility (23.30 ± 4.69), reaction time (12.85 ± 2.47) and sprinting performance (12.71 ± 1.21).

Table 4 Correlation of anthropometric variables with sprint performance

Anthropometric Variables	Calculated 'r'
Sitting Height	0.17
Standing Height	0.47*

Body Weight	0.47*
Chest Circumference	0.41*
Arm Length	0.60*
Leg Length	0.77*
Arm Girth	0.51*

Tab ‘r’ $_{(28, 2)}$ = 0.361 at 0.05 level of Significance

Table 5 Relationship of motor variables with sprint performance

Motor Variables	Calculated ‘r’
Explosive Strength	0.74*
Agility	0.46*
Flexibility	0.30
Reaction Time	0.73*

‘r’$_{(28,2)}$ = 0.361 at 0.05 level of Significance

Table 4 shows correlation of anthropometric and motor variables to sprint performance i.e. standing height (0.47), body weight (0.47), chest circumference (0.41) arm length (0.60), leg length (0.77) and arm girth (0.51) values were significantly higher than the tabulated value 0.361 at 0.05 level of significance. Sitting height (0.17), and flexibility (0.30) were insignificant correlation to the sprint performance because said variables values were less than table value 0.361 at 0.05 level of significance.

Table 5 shows that the correlation of motor variables with sprint performance i.e. leg explosive strength (0.74), agility (0.46) and reaction time (0.73) values were significantly higher than the tabulated value 0.361 at 0.05 level of significance. Flexibility (0.30) was insignificant correlation to the sprint performance because said variable value was less than table value 0.361 at 0.05 level of significance.

Table 6 Regression Analysis table

	Coefficient	p Value
Intercept	1.108	0.833
Sitting Height	-0.052	0.270
Standing Height	0.001	0.975
Body Weight	0.008	0.782
Chest Circumference	-0.081	0.116
Arm Length	-0.077	0.282
Leg Length	0.193	0.032* ($p \leq 0.05$)
Arm Girth	0.089	0.083
Explosive Strength	0.852	0.104
Agility	0.261	0.265
Flexibility	-0.051	0.175
Reaction Time	0.313	0.006* ($p \leq 0.05$)

Table 6 shows that the leg length p value 0.032 and reaction time p value 0.006 were less than the 0.05 value.

Table 7 Regression Equation Table

	Coefficient	p Value
Intercept	4.819	0.298
Leg Length	0.153	0.007
Reaction Time	0.177	0.023

Regression equation for these significant predictors:

$$\hat{Y} = bX + a$$

Predicted 100 meter Sprint Performance = 4.819 + 0.153 (Leg Length) + 0.177 (Reaction Time)

Discussion

It was found that there was a significant relationship between sprint performances of the study group and standing height, chest circumference, body weight, arm length, leg length and arm girth, explosive strength, agility and reaction time. Based on these results; it can be stated that when anthropometric characteristics (circumference and length measurements) and motor variables increases, speed performance could be increase as well. Based on the results of the analysis $R^2$of 4.819 indicating that the model has approximately accounted 48.19 % variability.

Leg Explosive Strength significantly highly correlated with sprint performance. Therefore explosive strength play a more important role in short distance running events. Horita et al. (1991) stated that improved horizontal jumping ability increases the range of motion of the lower limbs for the period of the flight phase of the sprint stride. Kale Mehmet et al (2009) it is thought that horizontal jumps provide significant impulses for shorter amortization recovery phases of the strides. More powerful sprinters have short foot contact time with the ground, longer stride length and flight time (FT) (Faccioni, A. 1996), and more stride frequency (Enoka, RM 1994). Morin and Belli (2003) stated that jump power is the best indicator of sprint ability. Jump tests provide evaluations for lower-limb power capability and give valid assessments of muscular power (Bret, C et al 2002). Greater muscle power is necessary for maximum jump and sprint running (27 Kukolj, M et al 1999). Morin and Belli (32) stated that jump power is the best indicator of sprint ability. Jump tests provide evaluations for lower-limb power capability and give valid assessments of muscular power (Bret, C, et al 2002 ,Kukolj, M et al 1999). Contracting at a high velocity and rapid stretching of the lower-limb musculature suggest that relative explosive ability of hip and knee extensors is critical to sprint performance (Morin, JB et al 2003). Maximum muscle contraction force is necessary to achieve mechanical power in the starting speed and short sprint performance (Gambetta V 1991).

Flexibility was insignificantly correlated with sprinting performance which means flexibility play not much more but not least role in sprint performance. Skaggs J R et al (2015) was examine that flexibility and athletic performance we found no evidence that flexibility is associated with improved sprint and vertical jump performance. Increased hamstring flexibility, measured by knee extension angle, was associated with a decrease in vertical jump height.

Reaction time can help the sprinting performance during stages of sprint startThe Reaction Time depends upon the nerves and nerve processes and their roles ends as soon as the individual executes the first movement and thereafter for the entire duration of running other motor qualities continue to affect the performance for much longer duration. . TønnessenEspen et al (2013) sprinter's reacting abilities (reaction ability) affects their sprint performance over 100 meters. Reaction time variables have an important part to play in contributing to better performance in track and field events.

Agility was also highly correlated with hundred meter sprint performance, so agility is an important component of sprinter athletes. Vescovi, Jason D. & Mcguigan, Michael R. (2008) the Illinois and pro-agility tests were correlated with each other as well as with linear sprint times. Sporis, Goran et al (2010) Agility training into an overall conditioning programme of athletes striving to achieve a high level of explosive leg power and dynamic athletic performance.

Leg length has correlated with the sprint performance. Eliben's (1972) observed that in each anthropological character of the sprinters had long lower extremities especially their thigh. Amar (1920) pointed out that short heavyset people are remarkable strong and good weight lifter. The "grasshopper" type with relatively long legs (particularly forelegs) marks good jumper, runners and pole-vaulters. Tom Ecker (1985) stated that human running permit the body to float in the air between strides, with both feet off the ground approximately half the time. Thus the runners' strides can be considerably longer than the length of the legs. Great leg and thigh circumferences were significantly related to better speed, agility, ergo jump and vertical jump (Tarverdizadeh, B, Azarbayjani, M.A. 2012). The sprinters had small stature mainly due to their short trunk. Their lower extremities, especially their thigh were long as compared to trunk, the lower limb; especially the lower legs were strong with well-developed muscles. The hurdlers were also strong and muscular; their stature was nearly identical with the sprinters, however their trunk was somewhat lower and their lower extremities relatively shorter (Eiben, 1984). More powerful sprinters have short foot contact time with the ground, longer stride length and flight time (FT) (Faccioni A 1996), and more stride frequency (Enoka, RM 1994).

Arm length and arm girth have found significant correlation with the sprint performance. Arm length, arm girth play a contradiction force for increase to speed and maintain the direction. Greater lower arm length of long distance runners' provides greater range of movement and momentum, which favors in maintaining their speed (Muqarram M 2015). Mohammad (2015) also documented in his study performance is highly correlated with the arm length of the athlete. In this study same sort of results are reported.

Height and body weight have also a significant correlation with sprint performance. Speed is significantly associated with body mass and BMI in world-class runners and moderately with height (Sedeaud A, Marc A Dor F, Schipman J, Dorsey M, Haida A, Berthelot G, Franc J ¸ Toussaint, (2014)). Athletes, on average were continuously lighter and smaller with distance increments. For taller athletes, mass that falls from a higher altitude falls faster, down and forward [21 Bejan A, Marden JH (2006)]. Bejan and Marden [2006] also show that the speed-height relation is predictable from the power law applied to animal locomotion. Speed increases with larger physiques in different species including mammals and human. For example, 3 percent increase in the height of the center of mass means a 1.5 percent increase in runners speed [21 Bejan A, Jones EC, Charles JD (2010)].

Conclusions

Sprinting performance could be depends on motor variables and anthropometric characteristics but not cent percent. The way of scientific training, dietary supplements and psychological factors may also add with motor and anthropometric characteristics. Motor variables i.e. leg explosive strength, agility, reaction time and anthropometric characteristics i.e. standing height, body weight, chest circumference, arm length, leg length, and arm girth are important parameters for talent identification on college level sprinters. Each components of motor variables and anthropometric characteristics must be considered independently when designing training programme for sprinters.

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