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Somatotyping and Biomotor Features of Male Children of Chandauli and Mirzapur Districts of Uttar Pradesh, India

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Abstract: Five hundred and one (501) male children aged between eight and fourteen years were selected randomly from the districts of Chandauli and Mirzapur, Uttar Pradesh, India for establishing the association between components of somatotyping and biomotor features. Heath- Carter technique was used to determine the somatotyping of the children. Hand grip strength, sit and reach test, vertical jump and 4x10m agility test were used for biomotor features. Product moment correlation was used to determine the relationship between somatotyping and biomotor features. Socioeconomic conditions, nutritional inadequacies and geographical factors might have an influence on the physical growth of the studied population along with their genetic constitution. Significant relationships were observed when correlated the somatotype components with physical fitness parameters. Somatotype, as the indicator of children's body development, was an acceptable predictor to explain variations in the physiques of children. Hereditary and external factors such as regular activity, nutritional status, and motivation of parents and teachers must also be taken into account while trying to explain the various levels of physical fitness in the children.

Keywords: Somatotype, Hand-Grip strength, Vertical jump, Sit and Reach test, Agility

1. Introduction

Somatotype was a method of classifying the human topology with respect to three extreme body types:- endomorphy, mesomorphy, and ectomorphy, and was developed by the U.S. Psychologist W.H. Sheldon in the year 1940 , later on modified by Barbara Honeyman in 1963 and J.E.Lindsay Carter in 1966 and finally by Barbara Heath and J.E.L. Carter in 1967.

Biomotor ability is the ability of an individual to perform an exercise as the cause, and the movement itself is just the effect; therefore, it is the ability to control the causes to perform a successful effect. The biomotor abilities are caused largely due to genetic inheritability [1]. Abilities such as speed, strength, flexibility, endurance, balance and skill are most likely to be related to somatotype.

Since the early development of Sheldon's somatotyping technique, various researchers studied the relationship of somatotype and motor performance in sports [1,2,3,4,5,6,7,8.9.10]. Some of the studies were applied for finding out the relationships between physical characteristics and motor performance [2,3,4,5,6,7] and some of which were for identifying particular physical characteristics of athletes in different sports at various levels [8,9,10,11]. Comparatively fewer studies were reported on somatotype and physical fitness components, such as strength, speed, flexibility, endurance and balance in children[2, 4,10,12,13,14].

Physical fitness components had low positive relationship with mesomorphy and low negative relationship with endomorphy. Negative correlation between endomorphy and physical fitness is quite obvious in tasks requiring movement of the whole body. Ectomorphy showed either none or a slightly positive association with physical fitness test scores [6]. The negative relationship of endomorphy and mesomorphy with ectomorphy was normal because the definition of both endomorphy and mesomorphy showed the relative mass of the individual while the ectomorphy was taken as thin and linear. Mass was inversely proportional to ectomorphy i.e.

when one increased, the other decreased. In general, high values in endomorphy or mesomorphy tally with lower values in ectomorphy. It was more evident when moderate to high endomorphy and mesomorphy were taken together. The correlation between endomorphy and mesomorphy varied quite often and was indicative of little mutual predictive value. So, some subjects could have high mesomorphy along with widely variable endomorphy scores and vice versa [15]

The purpose of this study was to establish the relationship between somatotyping and biomotor abilities of male children in different age groups of 8 to 14 year selected from the districts of Chandauli and Mirzapur in the state of Uttar Pradesh, India.

2. Method

2.1. Subjects

501 male children ,age ranged from 8 to 14 year, were measured randomly from the primary and junior level schools of Uttar Pradesh, one of the northern provinces of India. Multistage random techniques were utilized to collect the samples . All the students were from Chandauli and Mirzapur districts of Uttar Pradesh province. The ages of the children were determined from their dates of birth in their school registers. Consents were taken from the parents as well as from school authorities prior to the measurements. The study was approved by the Research Ethics Committee of the Pondicherry University.

2.2. Anthropometric Measurements

Anthropometric measurements were obtained according to the International Society for Advancement of Kinanthropometry [16] guidelines. All measurements were taken only for the right-hand side of the body parts. Height was measured with an anthropometric rod to the nearest 1 mm. Body mass was measured in kilograms to the nearest 0.1 kg using an electronic weighing machine. All skinfold measurements (triceps, subscapular, supraspinal and medial calf) were taken with the Harpenden skinfold caliper. Biepicondylar humerus width and biepicondylar femur width were measured to the nearest 1 mm using a small sliding caliper. Girths were measured with an anthropometric tape (Lufkin). All measurements were taken using cross-hand technique with 1 mm graduation. The corrections were done as proposed by Hebbelinck et al [12] with Technical Error of Measurements (TEM).

2.3. Somatotype

For the assessment of somatotyping, the Heath - Carter somatotype technique was applied. There are 10 body measurements required such as height, weight, four skinfolds, two width and two girth measurements redundant.

Heath-Carter [17] method was followed for somatotyping rating as follows:

1. *Endomorphy* = $-0.7182 + 0.1451(X) - 0.00068(X^2) + 0.0000014(X^3)$, where X = (sum of triceps, subscapular and supraspinal skinfolds) multiplied by 170.18 (height in cm). This is called height-corrected endomorphy.
2. *Mesomorphy* = (0.858 x humerus breadth) + (0.601 x femur breadth) + (0.188 x corrected arm girth) + (0.161 x corrected calf girth) – (0.131 x height) + 4.5.

(Corrected arm girth = Arm girth - triceps skinfold/10; Corrected calf girth= (maximal
calf girth - calf skinfold)/10.)

3. *Ectomorphy*. Three different equations are used to calculate ectomorphy according to the height–weight ratio (HWR).
   i. If HWR is greater than or equal to 40.75, then *Ectomorphy* = 0.732 HWR – 28.58.
   ii. If HWR is less than 40.75 but greater than 38.25, then *Ectomorphy* = 0.463 HWR –17.63.
   iii. If HWR is equal to or less than 38.25, then *Ectomorphy* = 0.1.

2.4. Administration of Biomotor Abilities

Following tests for biomotor abilities were used which included handgrip strength test, vertical jump test, sit and reach test and 4 ×10 shuttle run.

1. Hand grip strength was measured in kg with the help of Grip strength dynamometer.
2. Lower hamstring flexibility was measured through Sit and reach test. The score was recorded to the nearest 1 mm.
3. Lower body explosive power was measured through vertical jump. The score was recorded to the nearest 1 mm.
4. Agility was measured through 4 ×10 shuttle run. The score was recorded to the nearest 0.01 seconds.

2.5. Inclusion/ Exclusion Criteria

The following points were included in the study:

1. The age spans were 8 to 14 years in male children.
2. Postural deformities such as kyphosis, round shoulder, lordosis, knock knee, and bowleg deformities in children were excluded.
3. Only government schools were taken into consideration.

2.6. Statistical Analysis

All statistical analyses were analyzed using the Statistical Package for the Social Science (SPSS) version 16. To establish the relationship between anthropometric variables and biomotor abilities, product moment correlation coefficient was used at $P<0.05$ and $P<0.01$ level of significant.

3. Result

Table 1. *Height of different age groups.*

Age (yr)	Min (cm)	Max (cm)	Mean (cm)	SD
8.0	111.10	134.00	123.18	6.01
9.0	115.40	137.70	129.33	5.10
10.0	121.30	143.80	131.31	5.39
11.0	122.00	167.50	137.58	8.34
12.0	127.90	151.80	138.26	5.17
13.0	133.00	163.20	145.53	6.87
14.0	133.60	168.20	152.57	8.85

Table 2. *Body mass of different age groups.*

Age (yr)	Min (kg)	Max (kg)	Mean (kg)	SD (kg)
8.0	16.60	25.50	20.98	2.34
9.0	18.20	29.80	23.47	2.70
10.0	18.50	32.10	24.38	3.34
11.0	20.30	40.10	27.62	3.49
12.0	21.70	39.40	28.74	5.50
13.0	22.30	45.80	32.28	4.95
14.0	25.20	54.80	38.37	7.12

Table 3. *Endomorphy, Mesomorphy, and Ectomorphy components of children at different ages.*

Age (yr)	Endomorphy				Mesomorphy				Ectomorphy			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
8	.67	2.18	1.5	.3	2.0	6.34	3.7	.7	2.3	6.4	4.2	0.9
9	.84	2.74	1.3	.3	2.4	4.65	3.6	.5	1.3	6.2	4.5	1.0
10	.79	2.40	1.4	.4	2.2	5.63	3.6	.7	1.5	7.0	4.7	1.0
11	.71	2.37	1.3	.3	2.1	5.45	3.8	.7	2.0	6.3	4.4	0.7
12	.65	2.46	1.3	.4	1.6	5.25	3.5	.7	3.1	7.8	4.9	1.0
13	.62	2.90	1.2	.4	2.3	6.05	3.7	.8	1.4	7.0	4.9	1.0
14	.71	3.21	1.4	.6	.50	6.29	4.0	.8	2.5	7.6	4.7	1.0

Table 4. *Correlations between somatotype components and biomotor features of subjects among the 8-year group (RHGT: right hand grip strength, LHF: lower hamstring flexibility, VJ: vertical jump,agility).*

VARIABLES	ENDO	MESO	ECTO	RHGT	LHF	VJ
MESO	0.245					
ECTO	-0.217	-0.783				
RHGT	-0.043	0.184	-0.142			
LHF	-0.266	-0.103	0.111	-0.160		
VJ	.036	-0.096	0.121	0.038	-0.390	
AGILITY	0.015	0.062	-0.092	-0.093	0.189	-0.348

The data displayed in the Table 4 showed significant positive relationship (0.245, P<0.05) between endomorphy and mesomorphy and significant negative relationship (-0.266, P<0.05) between endomorphy and flexibility; also significant negative relationship is obtained (-0.783, P<0.01) between mesomorphy and ectomorphy, between flexibility and vertical jump (-0.390, P<0.01) and between vertical jump and agility (-0.348, P<0.01). No other relationships occurred between the variables.

Table 5. *Correlations between somatotype components and biomotor features of subjects among the 9-year group (RHGT: right hand grip strength, LHF: lower hamstring flexibility, VJ: vertical jump,agility).*

VARIABLES	ENDO	MESO	ECTO	RHGT	LHF	VJ
MESO	0.068					
ECTO	-0.121	-0.671				
RHGT	0.298	0.205	-0.295			
LHF	0.133	0.068	-0.013	-0.049		
VJ	-0.029	-0.008	-0.004	0.251	-0.160	
AGILITY	-0.134	-0.117	0.137	-0.395	0.235	-0.354

The data displayed in Table 5 showed significant positive correlation between endomorphy and grip strength (.298, P<0.05) and between grip strength and vertical jump (0.251, P<0.05) while negative significant correlation is obtained between mesomorphy and ectomorphy (-0.671, P<0.01), between ectomorphy and grip strength (-.295, P<0.05), between grip strength and agility (-.395, P<0.01) and between vertical jump and agility (-.354, P<0.01). No significant relationships were found between the other variables.

Table 6. *Correlations between somatotype components and biomotor features of subjects among the 10-year group ((RHGT: right hand grip strength, LHF: lower hamstring flexibility, VJ: vertical jump,agility).*

VARIABLES	ENDO	MESO	ECTO	RHGT	LHF	VJ
MESO	0 .340					
ECTO	-0.252	-0.598				
RHGT	0.048	0.471	-0.212			
LHF	0.301	-0.084	-0.071	-0.212		
VJ	-0.224	0.259	-0.085	0.404	-0.199	
AGILITY	0.018	-0.345	0.247	-0.419	0.245	-0.416

The data displayed in Table 6 showed significant positive relationship between endomorphy and mesomorphy (0.340, P<0.01), between endomorphy and flexibility (0.301, P<0.05), between mesomorphy and static strength (0.471, P<0.01), between mesomorphy and vertical jump(0.259, P<0.05), between ectomorphy and agility(0.247, P<0.05), between static strength and vertical jump(0.404, P<0.01), between flexibility and agility(0.245, P<0.05). Significant negative relationship is obtained between endomorphy and ectomorphy (-.252, P<0.05), between mesomorphy and ectomorphy (-0.598, P<0.01), between mesomorphy and agility (-0.345, P<0.01), between static strength and agility (-0.419, P<0.01), and between vertical jump and agility (-0.416, P<0.01). No significant relationship is found between the other variables.

Table 7. *Correlations between somatotype components and biomotor features of subjects among the 11-year group (RHGT: right hand grip strength, LHF: lower hamstring flexibility, VJ: vertical jump,agility).*

VARIABLES	ENDO	MESO	ECTO	RHGT	LHF	VJ
MESO	0.429					
ECTO	-0.273	-0.356				
RHGT	-0.012	-0.167	-0.081			
LHF	0.144	0.055	-0.050	-0.037		
VJ	-0.026	-0.126	0.160	0.552	0.136	
AGILITY	-0.083	0.094	-0.147	-0.420	-0.034	-0.430

The data displayed in Table 7 showed positive significant relationship is obtained between endomorphy and mesomorphy (.429, P<0.01) and between static strength and vertical jump (.552, P<0.01); significant negative relationship is obtained between endomorphy and ectomorphy (-.273, P<0.05), between mesomorphy and ectomorphy (-.356, P<0.01), between grip strength and agility (-.420, P<0.01), and between vertical jump and agility (-.430, P<0.01). No significant relationship is found between the other variables.

Table 8. *Correlations between somatotype components and biomotor features of subjects among the 12-year group (RHGT: right hand grip strength, LHF: lower hamstring flexibility, VJ: vertical jump,agility).*

VARIABLES	ENDO	MESO	ECTO	RHGT	LHF	VJ
MESO	0.308					
ECTO	-0.344	-0.660				
RHGT	0.173	0.102	-0.002			
LHF	0.114	-0.048	0.117	-0.164		
VJ	0.217	-0.007	0.033	0.257	-0.289	
AGILITY	-0.180	-0.039	-0.006	-0.167	-0.008	-0.491

The data displayed in Table 8 showed significant positive relationship between endomorphy and mesomorphy (0.308, P<0.01) and between grip strength and vertical jump (0.257, P<0.05). Significant negative relationship is obtained between endomorphy and ectomorphy (-0.344, P<0.01), between mesomorphy and ectomorphy (-.660, P<0.01), between flexibility and vertical jump (-0.289, P<0.05) and between vertical jump and agility (-0.491, P<0.01). No significant relationship is found between the other variables.

Table 9. *Correlations between somatotype components and biomotor features of subjects among the 13-year group ((RHGT: right hand grip strength, LHF: lower hamstring flexibility, VJ: vertical jump).*

VARIABLES	ENDO	MESO	ECTO	RHGT	LHF	VJ
MESO	0.374					
ECTO	-0.584	-0.719				
RHGT	-0.063	-0.180	0.178			
LHF	-0.037	-0.107	0.126	0.433		
VJ	0.014	-0.004	0.048	0.244*	0.112	
AGILITY	0.043	0.143	-0.072	-0.133	-0.189	-0.544

The data displayed in Table 9 showed significant positive relationship between endomorphy and mesomorphy (0.374, P<0.01), between grip strength and flexibility (0.433, P<0.01) and between grip strength and vertical jump (0.244, P<0.05). Significant negative relationship is obtained between endomorphy and ectomorphy (-.0584, P<0.01), between mesomorphy and ectomorphy (-0.719, P<0.01) and between vertical jump and agility (-0.544, P<0.01). There are no significant relationships between the other variables.

Table 10. *Correlations between somatotype components and biomotor features of subjects among the 14-year group ((RHGT: right hand grip strength, LHF: lower hamstring flexibility, VJ: vertical jump).*

VARIABLES	ENDO	MESO	ECTO	RHGT	LHF	VJ
MESO	0.366					
ECTO	-0.583	-0.538				
RHGT	0.129	0.086	0.020			
LHF	-0.009	0.273	-0.076	-0.120		
VJ	0.045	0.028	-0.048	0.433	-0.093	
AGILITY	-0.100	-0.118	0.103	-0.383	0.086	-0.421

The data displayed in Table 10 showed significant positive relationship between endomorphy and ectomorphy (0.366, P<0.01) and between grip strength and vertical jump (0.433, P<0.01). Significant negative relationship is obtained between endomorphy and ectomorphy (-0.583, P<0.01), between mesomorphy and ectomorphy (-0.538, P<0.01), between grip strength and agility (-0.383, P<0.01) and between vertical jump and agility (-0.421, P<0.01). No significant relationships are found between the other variables

4. Discussion

The objective of this study was to determine the anthropometric and bio-motor abilities of male children with ages ranging from 8 to 14 years from the districts of Chandauli and Mirzapur, Uttar Pradesh. In the present study, the endomorphy components were positively correlated with mesomorphy components where correlation coefficients were ranged between 0.068 and 0.429 (P<0.05, P<0.01) in all the age groups except 9 year age group where the relationships between ectomorphy and endomorphy along with ectomorphy and mesomorphy are significantly negative at (P<0.05, P<0.01) level. The correlation coefficient between endomorphy and ectomorphy was with a range of -0.121 to -0.584 and between mesomorphy and ectomorphy the range was between -0.356 to -0.783). The value of correlation coefficient varied might be due to the differences of values of some components within the samples. The negative relationship of endomorphy and mesomorphy with ectomorphy was to be expected because the definition of endomorphy and mesomorphy described relative mass of the individual while the ectomorphy was defined as thin and linear. When mass increased, the ectomorphy decreased. In general, high values in endomorphy or mesomorphy correspond to lower values in ectomorphy. This was more pronounced when moderate to high endomorphy and mesomorphy were combined. The correlation between endomorphy and mesomorphy varied quite often and indicated little mutual predictive value. This meant that some subjects could have high mesomorphy in the presence of widely variable endomorphy scores and vice versa. [15]. Physical fitness tests had been used as a criteria measures in studying the relationships between somatotype and performance. Test of strength, endurance and speed were more related to somatotype than tests of flexibility, balance, eye-hand coordination or speed of limb movement, especially at the extremes of physical performance [4,18,19]. In the present study, endomorphy and lower hamstring flexibility were significantly associated with each other (r = -0.266) which was negative for the 8year age group. On the contrary , endomorphy component and right hand grip strength were negatively correlated with other (-.0298) whereas ectomorphy component and right hand grip strength were also negatively correlated with a correlation coefficient value of -0.295 for the 9 year age group. Right hand grip strength showed positive associations with endomorphy component (r =0.301) and mesomorphy component (r =0.471) for the 10 year age group. Consequently mesomorphy component showed positive association with vertical jump (r = -0.259) and negative association with agility (r = 0.345) whereas ectomorphy component showed positive association with agility (r =0.247).

In general, components of somatotype had an impact on various biomotor abilities in prepubertal age groups (8 to 10 year age groups). Slaughter et al [7] revealed that somatotype made up for 12 to 18% of the variance in physical fitness for 7 to 12-year old boys. The finding of the present study was very close to the studies of Slaughter et al [7] and Yavuz [20]. Perhaps the somatotype accounted more for the prediction of prepubertal biomotor abilities of children than in pubertal children. The finding of the present study did not support the study of Saar [21].

Despite the caveats, different studies suggested that high mesomorphy component value was positively associated with physical performance and high ectomorphy component was negatively associated with the same. Ectomorphy showed either slightly positive association or no association. Test for strength, endurance, power and speed were highly correlated with somatotype than tests for flexibility, balance and fine motor skill, which seemed to be unrelated [22] which was supported by the findings of the present study.Concerning the relation of somatotype with physical fitness, it should be stressed that, more important than the association of each major component with performance, it was critical to consider the degree of relative presence of each component defined by morphological typology[23].

Endomorphy expressed the degree of adiposity development [24]. So the primary effect of endomorphy component in performance would differ depending on the type of task, being a limiting factor in body propulsion and lifting tasks in which body fat plays a similar function [23]. Malina and Bouchard [24] also reported that endomorphy, unlike the tasks of throwing objects, tends to negatively correlate with performance on most motor tasks, because the absolute lean body mass was more related to these tasks than the relative lean body mass.Mesomorphy represented the relative skeletal-muscle magnitude (robustness) and therefore associated positively with strength and motor performance in general [24].Ectomorphy reflected linearity and muscular hypotonia [25]. There were only positive associations for ectomorphy with propulsion and lifting body tasks, precisely the reverse of the associations for endomorphy and mesomorphy because of the negative effect of body weight in these tasks [25]. Regarding handgrip strength, there was a negative association, since it was a different test, which did not require propulsion or lifting the body. Ectomorphy represented the relative thinness of the subject and therefore associated negatively with strength [24].

5. Conclusion

The present study concluded somatotype as the indicator of children's body development and could be recognized as an acceptable predictor for explanation of variations in the physiques of children. Hereditary and external factors such as regular activity, nutritional status, and motivation of parents, teachers etc. must also be taken into account while trying to explain the various levels of physical fitness in the children.

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