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Motor Fitness and High Intensity Effort in University Students-A Gender Variation

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Abstract

Majority of college and university students do not participate in moderate or vigorous physical activity in daily life and this causes deterioration of physical fitness. Several sex differences in fitness profile parameters among college students were noted in different populations. But data of motor fitness parameters in University students are lacking, especially in Indian context. The present study was aimed to provide gender specific motor fitness reference standards among Indian University students from Kolkata. 82 non–smoker male (n=41) and female (n=41) university students belonging to the age group of 20–26 years and similar socio–economic background were recruited in the study. Motor fitness parameters (agility, vertical jump test, push up test, flexibility, hand grip strength) and anaerobic capacity were measured by standard methods. Motor fitness parameters (agility, vertical jump test, push up test, flexibility, hand grip strength) and anaerobic capacity were significantly higher in male students than their female counterparts. Present data will also serve as a national standard data of motor fitness parameters of university students. This would be of further help to fitness instructors towards implementation of better fitness or exercise regime in different populations to improve physical fitness and for preventing injuries by increasing muscles' flexibility especially in case of females.

Keywords: Agility; Male; Female; Flexibility; VJT

Abbreviations: FLXT: Flexibility, VJT: Vertical Jump Test, HIE: High Intensity Effort; LHH: Left Hand Horizontal; RHH: Right Hand Horizontal; LHV: Left Hand Vertical; RHV: Right Hand Vertical; AHGS: Average Hand Grip Strength; BSA: Body Surface Area; BMI: Body Mass Index.

Introduction

Now a days, a turn down in physical activity among college students has been observed [1]. Regular physical activity plays a key role to maintain healthy lifestyle in all generation of population [1,2]. Decreased physical activity is associated with decreased values in different fitness profile parameters, viz., lungs volumes, flexibility, anaerobic capacity, muscle mass, etc., and simultaneously it increases the risks of several health problems [3]. Consequently complete sedentary life style causes deterioration of physical fitness and onset of various health problems [2].

Previous studies indicated that almost half of the college students did not participate in moderate or

vigorous physical activity in daily life [1]. Physical fitness is a valuable part of health monitoring in adults [4]. Fitness is a multi-dimensional construct that contains skills and health related components and there have been several publications in previous years reporting on the physical fitness among college students [1,4-6].

Fitness profile parameters, e.g., push-up test, flexibility, agility, anaerobic capacity, etc., are also used as good predictors of fitness status not only in athletes but also in physically demanding professionals, such as fire fighters, military personnel, policemen as well as in sedentary people as a work-assessment tools [2,4,7].

Gender differences in fitness, likely reflect fundamental anatomical, physiological and behavioural differences between the different sexes [8]. Several sex differences in fitness profile parameters were noted in different populations [8,4]. But data of motor fitness parameters in University students are lacking, especially in the population of Kolkata, India. The present study was therefore aimed to provide gender specific motor fitness reference standards among Indian University students from Kolkata.

Materials and Methods

Subject Selection Protocol

82 non–smoker university students (male=41, female=41) belonging to the age group of 20–26 years and similar socio–economic background [9], were randomly sampled and recruited in the study by random sampling method from the post–graduate students of University of Calcutta, Kolkata, India. Subjects were neither suffering from any disease nor under any medication during the study time. They had no record of major diseases, bone fracture or injuries as well as they were not part of any exercise or training protocol. The sample size was calculated using the method of Das and Das where the input of confidence interval was set as 95% [10]. Ethical clearance was obtained from the Human Ethics Committee of the Department of Physiology, University of Calcutta. A written informed consent was obtained from all the subjects. The study was conducted at an environmental temperature ranging 20–23°C and relative humidity ranging between 40 and 45%.

Study Design

Each subject came to the laboratory for three days with a gap of at least 7 days in between two consecutive days of visits to avoid experimental exhaustions. They reported in the laboratory at 9 am in all the visits. Familiarisation trial protocol was conducted on the first day when they were described and demonstrated all the tests to allay apprehension. After that they were familiarised with the whole experimental procedure by acquainting them with the various experimental procedures. During the second and third visits, subjects performed the experiments for the collection of data.

Pre-exercise heart rate, blood pressure, flexibility and vertical jump test (VJT) were measured in the second day while agility, high intensity effort (HIE), push up and hand grip strength (HGS) were measured during the third visit. After arrival in the laboratory at 9 am, they took rest for half an hour to allow the body temperature, cardiovascular and respiratory parameters to settle down to a steady state. Subjects were asked to avoid any energetic activity (e.g., training, exercise etc.) on the days of evaluation and took light breakfast 2 to 3 hrs before the examination.

After taking the rest, pre-exercise heart rate was recorded from the carotid pulsation (average value of three reading) and blood pressure was measured (average value of three reading) by the auscultatory sphygmomanometric method. Body height and body mass were measured to an accuracy of ± 0.50 cm and ± 0.1 kg, respectively, by using a weight measuring instrument fitted with height measuring rod (Avery India Ltd., India) with the subject standing barefoot and wearing lowest amount of clothing. The body surface area (BSA) and body mass index (BMI) were calculated by using the following equations [11,12].

$$BSA\ (m^2) = (\text{Body mass})^{0.425} \times (\text{Body height})^{0.725} \times 71.84$$

$$BMI\ (kg/m^2) = \text{Body Mass (kg)} / (\text{Body height in meter})^2$$

Measurement of Flexibility by Modified Sit and Reach Test

Flexibility was measured by modified sit and reach test method [3]. Subject sat on the floor in barefoot with legs stretched out straight ahead as much as possible. The soles of the leg feet were placed parallel against a wooden box called “sit and reach box”. Both knees were fixed and pressed flat on the floor. The subject assumed a sitting position with the head, back, and hips against the wall (90" angle at the hip joint) and the feet against the sit and reach box. A sliding measurement scale or yardstick with a range of 0 to 90 cm is placed on the box. The subject was asked to place hand over hand and reach out level with the measurement scale. The initial reach was measured by keeping the head and back of the subject in contact with the wall; only scapular abduction was allowed at that time. The sliding measurement scale was then slid along the top of the box until the zero point of the scale was

even with the tip of the fingers of the subjects. The subject was asked to reach forward along the measuring line as highest as possible. It was ensured that the hands stayed at the same level and knees were fixed, flat on the floor, not one reaching further forward than the other. The subject reached out and held that position for one or two seconds while the distance was measured. Each participant repeated the test for three times with a gap of at least 5 min between the consecutive trials. The best of these three trials was recorded.

Determination of VJT Score

Vertical jump test (VJT) was measured by following the Sargent jump test method [13]. The subject chalked the end of his finger tips and stood beside a wall and reached up with the hand closest to the wall, keeping the feet flat on the ground. The point of the fingertips was marked as standing reach height of the hand, the mark distance from the ground was measured (L1). Then the athlete jumped vertically as high as possible with the attempt to mark on the wall at the highest reachable point of the jump (L2). The differences distance between L2 and L1 was recorded as the VJT score. The test was performed thrice with a gap of at least 10 minutes between the consecutive trials and the best of these three efforts was noted.

Determination of HIE

HIE was determined by the method of 60-yard shuttle run test which comprised shuttles of progressing distances with subject's maximum effort (high speed and acceleration) [3]. Three indicator cones were placed at the yard lines 5 yards apart. The subject started from one end, ran 5 yards and came back to the start point, then ran another 10 yards and back followed by another 15 yards and finally came back to finish the test at the start line as fast as possible. Thus the subject a total of 60 yards' distance was completed in a shuttle manner. The subject was required to touch the line with their hand at each turn, for a total of five touches. The time taken to complete the entire run was recorded by a using stop watch.

Measurement of Agility

Agility was measured by the shuttle run test method [3]. The subject was asked to run back and forth between two parallel lines as soon as possible. Two lines were marked 30 feet away from each other in the ground. Two wooden blocks cones were placed behind one of the lines. The subject started running from the line reverse to the blocks. The participant ran to the other line and picked up one block and returned it to put behind the starting line, then returned another time to pick up the second block, then ran back with the block to place it back across the starting line as quick as possible. The time taken for the entire running period was marked out with the help of a stop watch.

Determination of Upper Body Strength

Push up test was performed to determine the upper body strength [14]. The subject kept the hands approximately shoulder width apart in front leaning position. They kept the feet together without shoes. The arms, back, buttocks and legs were kept straight from head to heels throughout the test. The test started with bending the elbow and lowering the entire body until the top of the upper arms were parallel to the floor and the elbows were bent at an angle of 90^0. Then the subject returned to the starting position by extending the elbows until the arms were almost straight. They were instructed to perform this test in as many number as possible in one minute and the total number of times performed by the subject in one minute was counted and recorded. Three such trials were performed by each subject and the best score was recorded.

Determination of Hand Grip Strength

Hand grip strength was measured by hand–grip dynamometer (Inco, Ambala, India) [15]. Subjects hold the dynamometer keeping the arm being tested at right angle to the body from the shoulder keeping the elbow straight and erect towards the front or dorsal side of the body. The base of the dynamometer rested on the first metacarpal (heel of palm), while the handle rested on the middle of four fingers. The subject was asked to squeeze the dynamometer with maximum isometric effort as fast as possible without making any movement of any other body part. Hand grip strength was measured in both the hand in horizontal and vertical postures. Thus, four hand grip strength scores were obtained in each subject, i.e., left hand horizontal (LHH), right hand horizontal (RHH), left hand vertical (LHV), right hand vertical (RHV), average hand grip strength of all hands (AHGS). Three such attempts were made by each subject with a gap of at least 3 min between the consecutive tests and best of these three trials was recorded.

Statistical Analyses

Data have been presented as mean ± SD. The normality of the distribution of data for each group was checked by Kolmogorov–Smirnov test. Two-tail student's t-test was performed to analyse the significance of difference between mean values recorded in male and female groups.

Results

Values of age, body height, body weight, BMI, BSA, pre-exercise heart rate and blood pressure have been presented in table 1. Age, pre exercise heart rate and blood pressure did not show any significant inter group difference but body height, body weight, BMI and BSA were significantly ($p<0.05$) higher in the male students' group (Table 1).

Groups	Age (years)	Body Height (cm)	Body weight (kg)	BMI (kg/m²)	BSA (m²)	Pre-exercise Heart Rate (beats.min⁻¹)	Blood Pressure (mm of Hg)	
							Systolic	Diastolic
Male Students (n=41)	22.56 ± 0.89	168.94 ± 5.73	62.85 ± 8.50	22.04 ± 2.98*	1.72 ± 0.12	78.73 ± 4.97	116.73 ± 6.12	76.71 ± 6.25
Female Students (n=41)	22.44 ± 1.12NS	153.65 ± 5.19**	54.01 ± 8.95**	21.63 ± 2.76	1.50 ± 0.13**	80.62 ± 4.83NS	114.32 ± 5.78**	78.78 ± 5.07NS

Values are mean ± SD, *p<0.05, **p<0.001

Table 1: Physical and physiological parameters of the University Students.

Flexibility, VJT, HIE, agility, push up and hand grip strength score have been tabulated in table 2. Flexibility, VJT, push up and hand grip strength depicted significantly higher values in male students' group while HIE and agility score exhibited significantly ($p<0.001$) higher values in female students' group. Comparative data of the studied parameters with earlier studies were presented in table 3.

	FLXT (cm)	VJT (cm)	HIE (sec)	Agility (sec)	Push Up (times/min)	Hand grip strength (kg)				
						RHH	RHV	LHH	LHV	AHGS
Male Students (n=41)	24.13 ± 4.57	33.72 ± 4.18	9.72 ± 0.74	12.26 ± 0.84	18.24 ± 4.52	28.80 ± 4.97	30.16 ± 4.81	24.18 ± 4.22	29.09 ± 4.21	28.04 ± 3.87
Female Students (n=41)	21.94 ± 4.16*	24.45 ± 4.75**	12.38 ± 1.03**	14.17 ± 0.70**	12.32 ± 4.39**	18.27 ± 3.04**	20.71 ± 3.13**	17.56 ± 3.87**	18.34 ± 3.06**	18.72 ± 2.98**

Values are mean ± SD, *p<0.05,* *p<0.001.

FLXT= flexibility, VJT= vertical jump test, HIE= high intensity effort, LHH-left hand horizontal, RHH-right hand horizontal, LHV- left hand vertical, RHV- right hand vertical, AHGS= average hand grip strength

Table 2: Motor fitness and HIE parameters of the University Students.

Authors	Population	Gender	FLXT (cm)	VJT (cm)	HIE (sec)	Agility (sec)	Push Up (times/min)	AHGS (kg)
Ramos-Sepúlveda et al., 2016 [16]	Colombian-Indian	M	-	-	-	-		23.2 ± 8.4
		F		-	-	-	-	20.4 ± 7.7
Pribis et al., 2010 [1]	Colombian	M	25 ± 10.0	-	11.3 ± 0.9	-	-	41.7 ± 12.0
		F	31 ± 9.0		11.9 ± 1.2	-	-	23.8 ± 7.4
Ramírez-Vélez et al., 2015 [17]	Colombian	M	21.1 ± 6.7	32.6 ± 14.6	13.4 ± 1.6			19.6 ± 8.9
		F	24.7 ± 7.8	24.9 ± 6.7	14.9 ± 1.6	-	-	16.9 ± 5.1
Sekulic et al., 2013 [18]	Croatian	M	-	-	5.21 ± 0.39	8.36 ± 0.72	-	-
		F	-	-	5.84 ± 0.6	9.2 ± 0.58	-	-
McManis et al., 2004 [19]	American	M	-	-	-	-	17.9	-
		F	-	-	-	-	15.6	-
Augustsson et al., 2009 [7]	Swedish	M					39 ± 13	
		F					17 ± 10	
Present study	Indian	M	24.13 ± 4.57	33.72 ± 4.18	9.72 ± 0.74	12.26 ± 0.84	18.24 ± 4.52	28.04 ± 3.87
		F	21.94 ± 4.16	21.94 ± 4.16	12.38 ± 1.03	14.17 ± 0.70	12.32 ± 4.39	18.72 ± 2.98

Values are mean ± SD. FLXT= flexibility, VJT= vertical jump test, HIE= high intensity effort, AHGS= average hand grip strength.

Table 3: Comparison of present data with the earlier studies.

Discussion

The main objectives of this study were to report motor fitness reference standards among Indian University students of both genders of Kolkata. These results showed that the male university students performed better than the female university students in speed, lower and upper body strength (push up and VJT), flexibility, agility and HGS parameters. The main strength of this study, and in terms of the normative values hereby provided, is the strict standardization of the fieldwork among the Indian community.

Flexibility

Flexibility is an important parameter in fitness profile not only in athletes but also among young generation [2-4]. In this present study significantly higher ($p<0.05$) values of flexibility score was noted in male university student group (24.13 ± 4.57 cm) than their female counterparts (21.94 ± 4.16 cm). This finding corroborated with previous research among Columbian school student, where male students exhibited lower value of flexibility score in male (21.1 ± 6.7 cm) than the female students (24.7 ± 7.8 cm) [17]. Some contradictory finding also noted with the earlier report by Shields et al., in 2010, they also established that the Canadian adult (age range 20-39 years) male depicted significantly lower value of flexibility score in male (25 ± 10.0 cm) than their female (31 ± 9.0 cm) population as well as Columbian college students, where male students exhibited greater value of flexibility score (43.1 ± 11.6 cm) than the female students (37.8 ± 12.1 cm) [1,8].

VJT

In this present study significantly higher ($p<0.001$) value of VJT score in male university students' group (33.72 ± 4.18 cm) was observed than the female students' group (21.94 ± 4.16 cm). Colombian-Indian adolescent boys exhibited significantly ($p<0.001$) greater value of jump height (169.9 ± 28.3 cm) than their girl (151.6 ± 31.7 cm) counterparts [16]. Similar finding was also noted among Columbian school student, where male students exhibited greater value of VJT (32.6 ± 14.6 cm) than the female students (24.9 ± 6.7 cm) [17]. Previous researches have demonstrated that Canadian males had higher values of strength than females [20].

High Intensity Effort

In this present study significantly lower ($p<0.001$) value of HIE score in male university student group (9.72 ± 0.74 sec) was observed than the female student group (12.38 ± 1.03 sec). Colombian-Indian adolescent boys exhibited significantly ($p<0.001$) better value of HIE (11.3 ± 0.9 sec) than the adolescent girls (11.9 ± 1.2 sec) [17]. Similar finding was also noted in Columbian school student, where male students exhibited greater value of HIE score (13.4 ± 1.6 sec) than the female students (14.9 ± 1.6 sec) [17]. Similar finding was also noted among Croatian college students, where male students (age 21.6 ± 2.1 years) exhibited significantly better HIE score (5.21 ± 0.39 sec) than the female students (5.84 ± 0.6 sec) [18].

Agility

In the present study significantly better ($p<0.001$) value of agility score in male university students' group (12.26 ± 0.84 sec) was observed than the female students' group (14.17 ± 0.70 sec). Similar finding was also noted among Croatian college students, where male students (age 21.6 ± 2.1 years) exhibited significantly better agility score (8.36 ± 0.72 sec) than the female students (9.2 ± 0.58 sec) having same age range (age 20.6 ± 2.1 years) [18].

Push Up

In this present study significantly higher ($p<0.001$) value of push up test in male university students' group (18.24 ± 4.52 times/min) was observed than the female students' group (12.32 ± 4.39 times/min). Similar finding was also established in previous study among Swedish male University students (age 23 ± 3.0 years) who exhibited significantly ($p<0.001$) higher push up score (39 ± 13 times/min) than the female students (17 ± 10 times/min) having same age range (age 23 ± 2.0 years) [7]. This finding also corroborated with American school students, where male students exhibited significantly higher push up score (17.9 times/min) than the age–matched female students (15.6 times/min) [19]. Similar finding also noted among American males (age 25 ± 7.0 years) exhibited significantly better push up score than their female counterpart having same age range (age 22 ± 3.0 years) [21].

Hand Grip Strength

In this present study significantly higher ($p<0.001$) value of HGS in male university student group [(LHH 24.18 ± 4.22; LHV 29.09 ± 4.21; RHH 28.80 ± 4.97; RHV 30.16 ± 4.81) kg] was observed than the female university student group [(LHH 17.56 ± 3.87; LHV 18.34 ± 3.06; RHH 18.27 ± 3.04; RHV 20.71 ± 3.13) kg]. Similar finding was also reported in Columbian college student, where male students exhibited greater value of HGS (41.7 ± 12.0 kg) than the female students (23.8 ± 7.4 kg) [1]. This finding also corroborated with earlier study where the Canadian adult (age range 20-39 years) males depicted significantly greater muscular grip strength than their female

counterpart [8]. Colombian-Indian adolescent boys exhibited significantly ($p<0.001$) greater value of HGS (23.2 ± 8.4 kg) than their adolescent girls (20.4 ± 7.7 kg) [16]. Similar finding also noted among Columbian school student, where male students exhibited greater value of HGS (19.6 ± 8.9 kg) than the female students (16.9 ± 5.1 kg) [17].

Conclusion

The present study revealed significantly higher values of motor fitness parameters in male students. It may be concluded that the male university students had better HIE, agility, push up score, HGS, VJT and flexibility than female university students. Present data will also serve as a national standard data of motor fitness parameters of university students. This would be of further help to fitness instructors towards implementation of better training or exercise regime in different populations to improve physical fitness and for preventing injuries by increasing muscles' flexibility especially in case of females.

Limitation of the study

Although the dietary and fluid intake patterns influence the motor fitness parameters, but it is a shortcoming of the study that these parameters were not evaluated in the present study.

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