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SOCIO-ECONOMIC STATUS AND PHYSICAL FITNESS PROFILE IN ADOLESCENT GIRLS OF EASTERN INDIA

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ABSTRACT ■ One hundred and thirty one XIth standard school going adolescent girls (age: 17 years) were randomly sampled from different government aided schools in Kolkata, India to evaluate their physical fitness according to their socio-economic status (SES). Physical and physiological parameters, body composition, explosive muscular power, flexibility, agility, muscular endurance, maximum oxygen consumption and anaerobic capacity were determined by standard procedure. The SES was also determined by standard scale. Individuals belonging to high SES group had highest in most of the physical fitness parameters. It was followed by the scores of low and middle SES groups. Apart from fitness data, the physical parameters, body composition items and skin-folds parameters were also measured irrespective of SES gradients. The findings of later parameters also indicated best physical health condition of girls belonged to high SES. It was followed by the girls belonged to low and middle SES groups respectively. The overall findings indicated, higher the socio-economic condition better the physical and physiological health condition of the adolescent girls.

Key words: Aerobic fitness, socio-economic scale, anaerobic capacity, flexibility, agility.

INTRODUCTION

Physical fitness in modern times is not a limit to one's ability to perform a specific task rather it refers to a holistic approach of human adaptability to cope with various life situations. Since, adolescence is the preparatory phase for leading a successful life in adulthood, staying physically fit should be in the priority list of adolescent people. The various threats to physical fitness of adolescents include, lack of physical activity, improper food habits, lack of exercise, sedentary life style and so on (Pavon et al. 2010).These in turn lead to adverse health complications, e.g, overweight and obesity, coronary heart diseases, hypertension, low bone density, diabetes, psychological problems like lack of attention, anxiety, depression, (Maghsoudi et al. 2010) etc. An individual's fitness profile depends on daily

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activities and dietary pattern which in turn directly depend on the SES (Drenowatz et al. 2010). Therefore, while conducting a study on physical fitness, the SES of the concerned population should also be considered.

Socio-economic status (SES) is an important determinant of health and well-being because it influences one's attitude, experience, and exposure to several health risk factors (Fiscella et al. 2004). Several studies showed that low socioeconomic characteristics are associated to a variety of chronic diseases (Maghsoudi et al. 2010, Drenowatz et al. 2010). The relation between low SES and health is not limited to adults as children belonging to low SES family are also prone to higher health risks since they are exposed to an unhealthy lifestyle (Pavon et al. 2010, Tremblay et al. 2010).

Physical fitness denotes the general state of health and well-being that precisely indicates the body's ability to perform either a daily activity task which is above sedentary nature or excelling one's ability in any kind of athletic or sports activity (Dalui et al. 2010). It is the mastery of several attributes of fitness including strength, endurance, power, speed, balance and coordination to perform and improve a task accurately in an able manner within a given time (Dalui et al. 2015). Literature indicated that mental, social and emotional health also influences the physical fitness (Basch 2011).

The SES has been studied in different overseas populations but similar study in Indian context is unavailable. Data of fitness profile in adolescent might be available in different regional populations in India although SES wise classification of fitness profile in the adolescent population of Eastern region of India is unavailable.

The present study was therefore aimed to evaluate the socio-economic status (Kumar et al. 2013) and fitness profile in adolescent girls of Higher Secondary section studying in different schools under the West Bengal Board of Secondary Education, Kolkata, India. The study was further focused to compare the data with their national and overseas counterparts.

Methods:

One hundred and thirty one (131) school going girls, from three Kolkata based schools were randomly selected for the current study. All the girls were 17 years old studying at Higher Secondary section under the West Bengal Council of Higher Secondary Education. Out of these 131 participants, 56 participants were selected from one school and 30 participants were selected from each of the rest of the two schools by random sampling method. Students with health complication or under medication were excluded from the study. Before the actual phase of data collection the school authorities were approached to obtain necessary permission to conduct the study. After getting the permission from the school authorities, the study protocol was explained and demonstrated prior to the actual working session to individual participant in presence of their parents and Head of the Institutions. The queries asked by the participants regarding experiments were attained by the researcher. The entire study was carried repeatedly in three different schools during 12th January 2015 to 28th August 2016. The detailed study design was as follows. Written informed consent was obtained from the guardians of the subjects as well as from the school authorities.

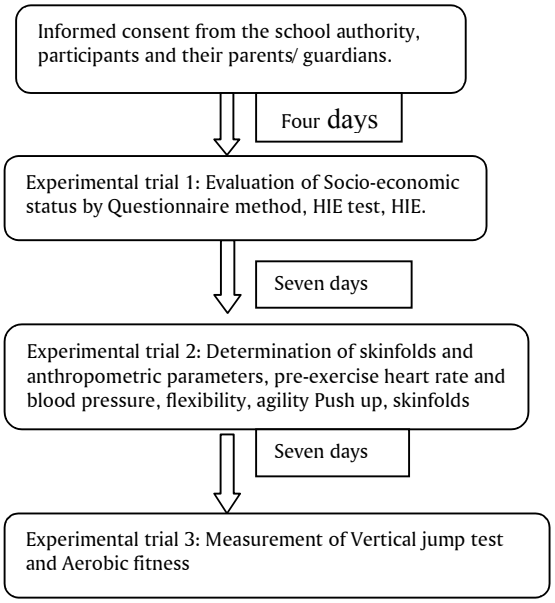
Study Design:

A cross sectional study was conducted on 131 Higher Secondary school children. Their age was calculated from the date of birth as

recorded in the Photo ID Card issued by the Government of India. The average age of the selected participants was 17 years.

Stratified random sampling technique was adopted for selection of four Govt. sponsored higher secondary schools from southern part of Kolkata, West Bengal, India. The study protocol was approved by the Human Ethical Committee of the Department of Physiology, University of Calcutta.

The schedule of different trials is shown in the following flow chart.



Preparation of Participants:

All the participants were attended by the researcher well in advance of the actual experimental session in each school. Informal interactions were made at that time to boost the confidence level of individual participant. Adequate rest was provided to all of them before the commencement of experimental trials in each day. Four participants were evaluated per day during the experimental trial session. Body height and body mass of the participants were measured by using a weighing machine fitted with height measuring rod (Avery India Ltd, India). They were asked to take rest for half an hour. After that the blood pressure and heart rate were measured. Body height and body weight were measured by using a weighing machine fitted with height measuring rod (Avery India Ltd.)

BSA and BMI were measured by using the following equations:

BSA (m^2) = $0.007184 \times \text{Height(cm)}^{0.725} \times \text{Weight(kg)}^{0.425}$ (DuBois and DuBois 1916)

BMI = (Weight in Kilograms / (Height in Meters × Height in Meters)

(Meltzer et al. 1988)

Waist hip ratio was calculated from the waist and hip circumferences.

Determination of Socio-economic Status (SES)

The Socioeconomic status (SES) of the participants was determined by applying a modified version of Kuppuswami's scale (Kumar et al. 2013). The scale comprises of three components namely education standard, occupation standard and income level of parents of the respective participant and accordingly the data were collected. The educational and occupational scores which are higher from either of the parents were summated with income scores of both of them to determine the final SES score of the respective participant. The obtained total scores were graded as <5 or 5-10=low SES, 11-25=medium SES and 26-29= high SES. The individual participant was assigned a position as low/medium/high SES on the basis of the final SES scores (Kumar et al. 2013).

Determination of VO_{2max}

The cardiorespiratory fitness or aerobic fitness was measured in terms of maximum oxygen consumption or VO_{2max}. It was evaluated by Queen's College step test (QCT) which comprised of stepping up and down on a stool of 16.25 inches height at a pace of 22 steps per minute for a total duration of 3 min. The

cadence of the step test was maintained by a metronome. The recovery heart rate was measured from 5th to 20th second of the recovery period and it was converted into heart rate in beats per minute. The following equation was used to compute the VO_{2max}.

VO_{2max} ($ml.kg^{-1}.min^{-1}$) = 65.81 – (0.1847 * 4* 15 sec recovery pulse) (Driss et al. 2013)

Determination of Anaerobic Power

The anaerobic power was determined by 60-yard dash test (Andrade et al. 2014). Three marker cones were placed at the yard lines by maintaining 5 yards distance. Each participant started running from one end, covered 5 yards and came back to the starting line. Immediately she started running 10 yards mark and again came back to the starting line and immediately thereafter ran to the 15 yards mark line and returned finally to the start line. Thus a total of 60 yards was covered. In each step, the participants were instructed to touch the ground line with their fingertips at each turn. Thus a total of five touches were made by individual. The time taken by participants to complete the total distance was recorded with a stopwatch.

Determination of Explosive Muscular Strength by Vertical Jump Test:

It was measured by keeping the participant in side wise standing posture on to a wall. She kept the feet flat on the ground, reached one hand up to touch the wall. The point on the wall touched by the fingertip of the middle finger was marked. This measurement gave the value of standing reach height. The participant then went little away from the wall and leaped vertically as much high as possible using both legs and hands to assist in projecting the body upwards. This step was performed thrice. The highest point touched out of three attempts was considered as best jump height. The difference between best jump height and standing reach height was measured to get explosive muscular strength (VJT) score (Mendes et al. 2015).

Measurement of Flexibility

Flexibility of the participant was measured by sit and Reach test (Bal et al. 2011). The participant was allowed to stretch her lags ahead. Shoes were removed. The soles of the feet were placed flat against the box. Both knees were locked and pressed flat to the floor. The tester assisted by holding them down. Keeping the palm facing downwards, the hands were kept on top of each other or aside by side. The participant reached forward along the measuring line as far as possible. It was ensured that both the hands were placed. Care was taken to keep the hands remain at the same level, not one reaching further forward than the other. After some trial practice, the participant reached out and held that position for about two seconds while the distance was recorded. Any jerky movement (knee jerk) was avoided.

Determination of Agility (by Shuttle run test)

The participant was allowed to run back and forth between two parallel lines as fast as possible. Two lines were set up 30 feet apart. Two wooden blocks were kept behind one of the lines. Starting at the line opposite to the blocks, on the signal "Ready, Go". The participants were asked to run to the other line and picked up one block and returned to place it behind the starting line. Then returned to pick up the second block and ran with it back across the line. The time taken for the entire running period was recorded using a stop watch (Lohman et al. 2008).

Measurement of Muscular Endurance

The muscular endurance of abdominal muscle was determined by 1 minute sit up test (Driss et al. 2013). The participants were instructed to lie down on a Yoga-mat comfortably. They then were told to fold the leg vertically at knee-joint and put both hands bellow the

head. Then a stopwatch was started and the participants were told to lift the upper portion of the body in forward direction and touch the fore-head with the knee. Thereafter, again they were lied down on the yoga-mat, keeping the legs bend as before. The same type of sequence of movements was repeated till completion of 1 minute. As 1-minute was over the stop-watch was stopped. The number of times a person can touch the knee with fore head gave the measure of sit up test for endurance of abdominal muscle.

Determination of Body Composition:

Body composition was determined by skinfold measurement by using the following formulae:

Body density (BD; $gm.cc^{-1}$) was determined from the following equations:

$BD = 1.0994921 - 0.0009929x_1 + 0.0000023x_1^2 - 0.0001392x_2$

(x_1=sum of triceps, suprailiac and thigh skin folds, x_2= Age in nearest years) (Jackson et al. 1980)

%Fat = (495/BD) – 450 (Siri 1961)

Total Body fat, percentage of lean body mass (%LBM) and total LBM were calculated using the following equations:

Total Fat or TF (kg) = %Fat/100 × Body Mass (kg)

%Lean Body Mass (%LBM) = 100- % Fat

LBM (kg) = Body mass (kg) – Total Fat (kg).

RESULTS

Values of body height, body mass, BMI, BSA, waist and hip circumference, waist-hip ratio, heart rate and blood pressure in different socio-economic groups have been presented in table 1. The medium high SES group showed highest mean values of height, weight, BMI, BSA, and heart rate parameters. The values of different skinfold thickness have been presented in table 2.

Table 1. SES wise values of anthropometric and physical parameters.

Socio-economic status		Body Height (cm)	Body Weight (kg)	BMI ($kg.m^{-2}$)	BSA (m^2)	WC (cm)	HC (cm)	WHR	HR ($beats.min^{-1}$)	BP (mm of Hg)	
										Systolic	Diastolic
Low (n=33)	Mean	153.72	46.30	19.50	1.40	23.78	30.25	0.78	73.15	103.21	65.78
	SD	4.51	10.55	3.79	0.14	2.12	2.34	0.05	6.00	9.62	6.55
Medium (n=80)	Mean	153.44	55.62	22.86	1.53	24.79	31.21	0.79	73.57	108.33	68.55
	SD	5.16	13.82	5.25	0.17	2.87	2.90	0.07	5.05	9.22	8.02
High (n=18)	Mean	155.78	46.09	19.55	1.40	23.14	29.71	0.77	74.61	103.51	66.81
	SD	5.26	7.90	3.07	0.11	3.21	3.45	0.06	5.18	7.97	6.59

SD, standard deviation; BMI, body mass index; BSA, body surface area; WC, waist circumference; HC, hip circumference; WHR, waist to hip ratio; HR, heart hate; BP, blood pressure.

Table 2: Different skinfolds in three SES groups

Socioeconomic status		Skinfolds (mm)							
		Biceps	Triceps	Sub-scapular	Supra-Iliac	Abdomen	Mid-thigh	Calf	Sum of skinfolds
Low (n=33)	Mean	5.97	7.85	8.71	13.41	13.31	13.88	12.32	75.48
	SD	1.72	1.70	1.33	1.82	2.74	3.11	2.11	11.28
Medium (n=80)	Mean	5.99	8.07	9.02	12.92	13.94	14.36	12.59	76.91
	SD	1.50	1.74	1.49	1.59	2.29	2.97	2.04	10.37
High (n=18)	Mean	5.48	8.88	10.37	12.14	13.68	13.61	12.7	76.88
	SD	0.97	0.91	1.45	1.69	2.08	2.25	2.16	10.72

SD= Standard deviation

ANOVA for SES wise value of anthropometric parameters and physical parameters.							
Various Anthropometric and Physical Parameters		Sum of Squares	df	Mean Square	F	Sig.	F- critical valus
Height	Between Groups	80.957	2	40.478	1.566	.213	3.066952
	Within Groups	3308.147	128	25.845			
	Total	3389.104	130				
Weight	Between Groups	1392.508	2	696.254	7.582	.001	3.066952
	Within Groups	11754.354	128	91.831			
	Total	13146.862	130				
BMI	Between Groups	171.514	2	85.757	6.539	.002	3.066952
	Within Groups	1678.598	128	13.114			
	Total	1850.112	130				
BSA	Between Groups	.253	2	.126	6.949	.001	3.066952
	Within Groups	2.330	128	.018			
	Total	2.583	130				
HR	Between Groups	25.075	2	12.537	.432	.650	3.066952
	Within Groups	3716.070	128	29.032			
	Total	3741.145	130				
Systolic	Between Groups	395.362	2	197.681	2.297	.105	3.066952
	Within Groups	11013.630	128	86.044			
	Total	11408.992	130				
Diastolic	Between Groups	89.288	2	44.644	.776	.462	3.066952
	Within Groups	7360.147	128	57.501			
	Total	7449.435	130				

Values of different skinfolds and different components of body composition in the three SES groups were presented in table 2. The middle SES group showed highest mean value for biceps, supra-iliac, abdomen, mid-thigh, calf and sum of skin-fold parameters the high SES group had highest score of triceps skin-fold.

ANOVA for Comparison of Various Skin-fold Parameters among the three SES groups.

Variables		Sum of Squares	df	Mean Square	F	Sig.	F- critical values
Biceps	Between Groups	3.937	2	1.969	.851	.429	3.066952
	Within Groups	296.132	128	2.314			
	Total	300.070	130				
Triceps	Between Groups	13.168	2	6.584	2.376	.097	3.066952
	Within Groups	354.610	128	2.770			
	Total	367.778	130				
sb-scplr	Between Groups	34.254	2	17.127	7.955	.001	3.066952
	Within Groups	275.575	128	2.153			
	Total	309.829	130				
sup-iliac	Between Groups	18.772	2	9.386	3.288	.040	3.066952
	Within Groups	365.359	128	2.854			
	Total	384.131	130				
Abdominal	Between Groups	9.195	2	4.597	.786	.458	3.066952
	Within Groups	748.992	128	5.852			
	Total	758.187	130				
mid-tigh	Between Groups	11.150	2	5.575	.637	.530	3.066952
	Within Groups	1119.397	128	8.745			
	Total	1130.547	130				
Calf	Between Groups	2.250	2	1.125	.253	.777	3.066952
	Within Groups	568.169	128	4.439			
	Total	570.419	130				
sum of BC	Between Groups	50.088	2	25.044	.215	.807	3.066952
	Within Groups	14889.699	128	116.326			
	Total	14939.787	130				

Different components of body composition in three different SES groups have been tabulated in table 3. The medium SES group depicted highest value of %fat. On the contrary the high SES population had highest values of LBM and %LBM compared to the other two groups. SES wise fitness profile data have been presented in table 4.

Table 3: SES wise values of different components of body composition.

Socioeconomic status		Body Density (gm/CC)	%fat (%)	%LBM (%)	Total Fat (kg)	LBM (kg)
Low(n=33)	Mean	1.41	14.69	85.30	6.80	39.45
	SD	0.0097	1.73	1.92	1.22	8.64
Medium(n=80)	Mean	1.06	14.81	85.18	8.23	39.19
	SD	0.0041	1.82	1.82	1.11	6.29
High(n=18)	Mean	1.06	14.56	85.43	6.71	47.33
	SD	0.0038	1.6	1.68	1.30	10.58

SD= Standard deviation

ANOVA for Comparison of Various Body-composition Parameters among the three SES groups

Variables		Sum of Squares	df	Mean Square	F	Sig.	F- critical valus
bd-dnsty	Between Groups	3.017	2	1.508	1.496	.228	3.066952
	Within Groups	129.025	128	1.008			
	Total	132.041	130				
% fat	Between Groups	1.106	2	.553	.161	.851	3.066952
	Within Groups	439.433	128	3.433			
	Total	440.540	130				
LBM	Between Groups	1010.346	2	505.173	8.447	.000	3.066952
	Within Groups	7655.462	128	59.808			
	Total	8665.808	130				

Values of different fitness profile parameters in different SES groups have been presented in table 4. The high SES group had highest scores of VO2max, flexibility and VJT. This group also had highest scores of muscular endurance, agility and anaerobic power in comparison to other two groups.

Table 4: SES wise values of different fitness profile parameters.

Socioeconomic Groups		QCT- HR (beats/ 15 sec)	QCT- HR (beats/ minute)	VO_{2max} ($ml.kg^{-1}.min^{-1}$)	Agility (sec)	Flexibility (cm)	VJT (cm)	Muscular endurance (steps/minute)	Anaerobic power (sec)
Low(n=33)	Mean	39.51	158.06	46.24	14.16	2.70	25.42	14.30	17.151
	SD	7.92	31.69	13.31	1.92	3.45	3.90	6.01	1.51
Medium(n=80)	Mean	37.9	151.6	44.94	14.30	2.67	22.67	13.05	16.72
	SD	6.81	27.26	11.45	2.32	3.38	4.64	6.409	1.81
High(n=18)	Mean	38.72	154.88	47.65	13.575	4.35	25.43	14.41	16.55
	SD	4.55	18.22	7.65	1.96	3.38	3.63	3.39	1.57

SD= Standard deviation

ANOVA for Comparison of Various **Physical - Fitness Parameters among the three SES groups**

Variables		Sum of Squares	df	Mean Square	F	Sig.	F- critical values
QCT HR (1 min)	Between Groups	1005.678	2	502.839	0.653	0.522	3.066952
	Within Groups	98608.857	128	770.382			
	Total	99614.534	130				
VO_{2max}	Between Groups	177.402	2	88.701	0.653	0.522	3.066952
	Within Groups	17394.602	128	135.895			
	Total	17572.004	130				
Agility (sec)	Between Groups	12.349	2	6.175	1.264	0.286	3.066952
	Within Groups	625.361	128	4.886			
	Total	637.710	130				
Flex (cm)	Between Groups	43.019	2	21.510	1.817	0.167	3.066952
	Within Groups	1514.923	128	11.835			
	Total	1557.942	130				
VJT (cm)	Between Groups	118.019	2	59.009	3.058	0.050	3.066952
	Within Groups	2469.969	128	19.297			
	Total	2587.987	130				
Push Up	Between Groups	27.538	2	13.769	.376	0.687	3.066952
	Within Groups	4685.302	128	36.604			
	Total	4712.840	130				
Anaerobic Capacity	Between Groups	5.592	2	2.796	.930	0.397	3.066952
	Within Groups	384.637	128	3.005			
	Total	390.229	130				

DISCUSSION

Adolescents' physical fitness is a, multidimensional problem, which not only needs physiological intervention but social intervention as well to make a better understanding of the situation. Therefore, adolescents' physical fitness issue must be incorporated in the major social and community health schedules in developing countries like India where people belong to a wide range of socio-economic disparity. (Mukherjee et al. 2014).

The results of the present study showed significantly higher body weight in medium SES group than high and low SES groups. The BMI value of high SES group was significantly lower than medium SES group. Data are set in table 1 (SES wise values of Anthropometric & Physical Parameters). This finding was in agreement with the study in Mauritian adolescents of 12 – 15 years of age (Fokeena et al. 2012).

BSA and BMI were significantly higher in Medium SES group than the High and Low SES groups. Heart rate, systolic pressure and diastolic pressure are in normal range in all the three SES groups and not statistically significant from each other (table 1). Unlike the present study, the earlier work (Mukherjee et al.2014) reported the Bengali adolescents of middle SES group had low BMI than prosperous strata of the society.

Subscapular and suprailliac skinfolds were significantly higher in the Medium SES group than the Low and High SES groups. However, the sum of skinfolds did not show any significant inter–group variation. Insignificant inter-group variation was noted in percentage of body fat parameter which was highest in middle SES group (table 2).

From the present finding it is clear that middle SES due to having highest BMI, and %fat, could be more prone to health diseases like coronary heart diseases, hyperglycemia, at a later stage as shown in earlier literature (Tesfaye et al. 2007 and Dollman et al. 2007). This may be due to sedentary life style, lack of physical activity, improper food habit, and lack of awareness about staying fit and healthy are the probable causes for the existence of such findings (Dollman et al. 2007). On the contrary, based on the current findings, it could be inferred that students belonging to high SES group are more physically fit, active and less prone to obesity. This finding is in agreement with the earlier finding in Australian 6^{th} standard school going children and European adolescents of 12.5 – 17.5 years of age (Ifeoma et al. 2015 and Rodrigues et al. 2006).

LBM was significantly higher in the high SES group than their Middle and Low counterparts (table 3).

LBM combats obesity as it is associated with basal metabolic rate (BMR). So greater the amount of LBM lesser is the value of BMI. Therefore, greater expenditure of calorie and avoidance of obesity in association with exercise. LBM also combats diseases in better way (Eisenmann et al. 2011). LBM can act as protein reserve which is necessary to power the increased demand of protein to boost the immune system to fight against infection. LBM contributes to strengthen bone and it is effective to prevent insulin resistance (Eisenmann et al. 2011).

The-VO2max scores of all three SES groups of the current study revealed higher than the Brazilian girls population aged 10 to 14 years(36.76 to 38.29 $mL.kg^{-1}.min^{-1}$) (Basch et al. 2011).On the contrary the present scores were lower than their American counterparts, aged 18years (~55 ml/kg/min) (Woods et al. 2015). The present agility scores are quite lower than another Indian study on adolescent girl population aged 12-16 years in which

agility score was 17.54±1.53 (Haugen et al. 2014).

The flexibility of present population is close to the Turkish girl population (4.58) of comparable age (Williams et al. 2001). The flexibility of high SES group possessed below average level as per international standard and the other two SES groups possessed scores far below the lowest level of international standard (Ortega et al. 2008).

The VJT scores of low and high SES groups were found greater and the middle SES group was found lower than the scores found in girls students (10 to 16 years) of Ecuador whose average VJT score was found 23.6 cm (Williams et al. 2001). This may be due to higher body weight in middle SES. Another study on Icelandic adolescent girls of 15 years age group reported 21.9 cm (Andrade et al. 2014), which is lower than all three SES groups of the present study.

The value of anaerobic capacity of high SES group was found lowest (16.55 sec). It was followed by the values of medium (16.72 sec) and poor (17.18 sec) SES groups, respectively. The muscle endurance scores of low, medium and high SES groups were 14.30, 13.05 and 14.41 push ups per minute, respectively (Dutt et al. 2005). The scores of VO2max, agility, flexibility, VJT, anaerobic capacity, muscle endurance of the current study have been shown in table 4

CONCLUSION

The trend of the present findings suggested the high SES group is having best physical fitness status, followed by low and medium SES groups respectively. The probable reasons for differences in physical fitness across the socio-economic diversity may include the adequate education and awareness of high SES group than the other two SES groups regarding the physical and mental health benefits of doing regular exercise and staying physical fit. The study depicted a clear indication of positive impact of socio-economic status on health and physical fitness. Since, educational back ground was one of the major determinants of SES (as per current SES scale), it could be recommended as a potential mediator for achieving sound physical fitness in school going children and adolescents across the existing socio-economic gradient in the region.

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