Shobha and Priti, J Obes Wt Loss Ther 2012, 2:5
DOI: 10.4172/2165-7904.1000137

Journal of
Obesity & Weight Loss Therapy

Research Article Open Access

Physical Activity, Adiposity and Blood Pressure Levels among Urban Affluent Adolescents in India

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Abstract

Objective: As adolescence is a period of great decline in habitual physical activity, it is important to examine its relationship with adiposity and its health consequences among adolescents.

Design: cross sectional study

Setting: School children from Pune city, India.

Subjects: Adolescent (9-16 yr) school children from high socio economic class (n=901) were measured for body weight, height, body fat, skinfolds, waist circumference and blood pressure. Physical activity data was obtained using a semi-structured activity questionnaire on overweight and their age-sex matched controls.

Results: Using conventional cut off**,** 24.8 % boys and 19.0% girls were overweight. Higher body mass index (BMI), body fat, skinfolds and waist were associated with higher prevalence of high blood pressure. Prevalence of overweight was significantly lower among children spending ≥ 90 min/d in outdoor games, among those spending ≥ 30 min/d in special activities and with total active time ≥ 200 min/d. In contrast, prevalence of overweight was higher among those with time spent in indoor games ≥ 60 min/d, TV viewing ≥ 120 min/d and having total inactive time ≥ 240 min/d. Higher inactivity showed positive association, while higher activity showed negative association with central adiposity as assessed by sum of subscapulr and suprailiac and waist circumference. Risk for overweight associated were- higher time in indoor games (OR: 1.66 95% CI = 1.02-2.70), less time in outdoor games (OR: 8.08, 95% CI: 4.8-13.6), higher inactive time (OR: 7.67, 95% CI: 4.3-13.4), higher time in TV viewing (OR: 11.6, 95 % CI 6.3-21.4). Risks associated with high blood pressure were not statistically significant.

Conclusion: The observations underscore the importance of promoting physical activity in adolescents for prevention of obesity.

Keywords: Physical activity; Adiposity; Indian adolescents

Introduction

Obesity in adolescents is a growing nutritional concern in countries like India, which is witnessing nutritional transition [1]. Childhood obesity too, has important health consequences for children and is a major antecedent of adult obesity [2]. As adolescence represents a period of great decline in habitual physical activity and a sensitive period for the development of obesity [3], it is important to examine the relationship between physical activity, overweight and its health implications among adolescents. Reported studies on adolescent obesity in urban Indian population are unfortunately scarce [4,5] and have not studied its health consequences. Physical activity and inactivity are two important determinants of obesity and represent major avenues for treating and preventing obesity.

Physical activity (PA) habits and specifically inactivity track significantly from adolescent to young adulthood [6]. PA is a global term referring to "any bodily movement produced by skeletal muscle those results in a substantial increase over the resting energy expenditure". Its objective assessment is challenging and difficult especially in field studies. Therefore, questionnaires are the most common instruments used in large scale studies because of their low cost and ease of administration. On the other hand, inactivity involves sedentary behavior and most sedentary activities have similar energy costs. For example, it includes participation in physically passive behaviors such as television viewing, reading, working at the computer, talking with friends on the telephone, meditating or eating etc.

Extensive research in the United States and few other countries have documented the effect of high levels of inactivity and television viewing on childhood obesity but little research has been undertaken in other developing countries where the exposure to television (TV) has not been long term [7]. With growing affluence and especially dramatic increase in TV and computer ownership documented in developing countries like India, it is likely that increase in sedentary behavior may result in childhood obesity. Present study therefore aims to examine patterns of physical activity, inactivity and their implications for obesity and blood pressure levels among urban affluent adolescents from Pune, India.

Methods

Study subjects

Three schools catering to boys and girls from urban area of Pune city were studied. A cross-sectional study was conducted by complete enumeration method. Thus all children from 5th to 10th standard covering the age 9-16 years (n=1890, 1026 boys & 864 girls) from these schools were included in the study. Absentees (3.6% boys and 4.2 % girls) on the days of the actual survey were the only exclusions. The study was approved by Institutional Research Advisory Committee.

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Received May 25, 2012; **Accepted** June 19, 2012; **Published** June 24, 2012

Citation: Shobha R, Priti A (2012) Physical Activity, Adiposity and Blood Pressure Levels among Urban Affluent Adolescents in India. J Obes Wt Loss Ther 2:137. doi:10.4172/2165-7904.1000137

Scio-economic information

Detailed socio-economic information was collected on each child with a view to identify children belonging to high socio-economic class (HSE). The information on ownership of house, number of rooms, family size, education and occupation of parents, ownership of vehicles, and foreign visits of parents in the previous year etc. was recorded. Using this information, a simple score was developed and those with total score of ≥ 50 were identifies as HSE. Data of these children (n=901) from high socio economic class was analyzed for the present study.

Anthropometry

Measurements were recorded on all children (n=901) in duplicate by trained investigators using standard procedures. Nevertheless, an Inter Observer Variability (IOV) study was done before starting the study. Between, investigators variation was negligible for weight & body fat which were measured with digital equipments. However, it was slightly higher in case of skin fold measurements (CV-5.0%) and therefore, investigator with the lowest standard deviation in case of skin folds measurement was kept constant for a particular measurement throughout the study. Weight was recorded (up to 20 g) using electronic weighing balance (Suysan, India), while height and sitting height were measured by stadiometer (upto 0.1cm). Skinfolds at four sites (triceps, biceps, subscapular and suprailiac) were measured (upto 0.1mm) using Harpenden's Calipers (CMS Instruments, London, U.K.) and were used to define central adiposity (sum of subscapulr and suprailiac) and peripheral adiposity (sum of triceps and biceps) while body fat was measured using Omran (HBF 300, Japan) equipment that works on principle of bio-electrical impedance analysis. Waist Circumference (WC) was measured using a non stretchable tape at midpoint of the last rib and the upper border of the iliac crest. Age assessment was done using birth date records from the school.

Assessment of overweight

Body Mass Index (BMI): For assessing prevalence of overweight, the conventional cut off of age, sex specific BMI, as given by International Obesity Task Force (IOTF) was used [8].

Body fat (%): Another indicator based on body fat % was also considered for estimating the prevalence of overweight in adolescents [9].

Blood pressure: A pediatrician who accompanied the team measured the blood pressure using sphygmomanometer (mercury). It was measured in a sitting position, on left hand using an appropriate size cuff, after a child had rest for at least ten minutes. Since the measurements of the students were taken during school timings, we were constrained to take a single measurement of blood pressure. We defined High Systolic Blood Pressure (HSBP) and High Diastolic Blood Pressure (HDBP) independently when measured Systolic Blood Pressure (SBP) or Diastolic Blood Pressure (DBP) of a child was above 95th percentile of value of blood pressure corresponding to his/ her age, sex and height percentile given by the Task Force Recommendations [10]. This corrects for the effect of height on BP and allows severity of BP elevation to be compared between groups of children of different heights.

Assessment of physical activity

Because of its complex nature, physical activity is difficult to assess precisely under free living conditions. Objective methods of assessing physical activity include accelerometers, heart monitors and pedometers, but are costly for large community based studies. Its assessment by observer maintained diary is possible, but may suffer from bias of altered behavior. Recalled activity therefore, might be the best one can do in large epidemiological study for objective assessment [11] and is considered to be the most practical option [12]. In contrast, inactivity or sedentary behavior can be defined as "a state when body movement is minimal and energy expenditure approximates resting metabolic rate".

Although different questionnaires have been used for adolescents in different settings, no single questionnaire is acceptable, reliable and valid due to variations across varying populations. Therefore, a population specific questionnaire is most suitable for specific objectives and needs to be developed. For the present study, a modified version of International Physical Activity Questionnaire (IPAQ) was used. The job-related physical activities used in the IPAQ were replaced by school-related activities. The recall period of one month was used since it is known to represent habitual activity pattern.

The questionnaire had six sub-sections which recorded activity i) at school (physical training periods per week for the class as well as for the entire school and conveyance (walk, cycle or car) to school, ii) details about study hours including those involved in tuitions iii) sports played both indoor, outdoor and participation in school games, if any, for various competitions iv) special interests in activities like swimming, gymnastics, trekking, jogging, yoga, dancing etc., v) recreational activities like watching television (no. of programs / movies etc.) or videos or computer/video games, and chit chatting vi) hobbies such as reading story books, learning musical instruments, vocal singing etc. The questionnaire was validated by testing on ten adolescent school children who recorded their activity for a whole week. Their parents were asked to record observer maintained diary for the purpose of validation. Minor changes were required to finalize the questionnaire.

Each child reported the time spent in different activities along with its frequency (daily/weekly/monthly). Time spent (min/d) was computed for each activity and was also considered in two main categories i.e. physical activity and inactivity involving sedentary behaviors.

For each child identified as overweight, an age-sex matched control child was selected from the remaining normal children (with BMI<85th percentile) enrolled in the study, using random number generation program in Foxpro (VFP 6.0). Data on activity could be collected on total of 300 children (150 overweight and 150 matched controls).

Statistical Methods

Trend in mean values of various anthropometric measurements for different age groups and in mean values of blood pressure levels was tested using one way ANOVA. In view of the significant ($p<0.000$) correlation of age with BMI (r=0.37 & 0.31 for boys and girls respectively) with body fat (r=-0.18 & 0.35 for boys and girls respectively), with peripheral skinfolds (r=0.08 &0.15 for boys and girls respectively), with central skinfolds (r=0.2 & 0.28 for boys and girls respectively) and with waist circumference (r=0.48 & 0.34 for boys and girls respectively), age adjusted tertiles were computed and were used to examine association of adiposity with blood pressure. Mean time spent in various activities by overweight and control children was compared using student's '*t*' test. Proportion of overweight children by levels of activity and prevalence of HSBP and HDBP by levels of adiposity were tested using Z test for a linear trend in proportion (13).

Age (yr)		BMI (kg/m²)[1]		Body fat (%)[2]		Mean SBP[3]		Mean DBP[3]	
Boys									
	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
9-11	149	17.26	3.1	23.01	6.1	101.92	8.8	68.10	6.7
11-13	182	18.86	3.6	22.25	5.9	107.32	11.4	71.27	6.6
> 13	185	20.18	3.5	20.41	5.2	111.36	10.4	74.10	7.4
Total	**516**	**18.8**	**3.6**	**21.8**	**5.8**	**107.2**	**11.0**	**71.3**	**7.3**
% prevalence		**24.8**		**48.2**		**6.6**		**8.1**	
Girls									
9-11	111	17.67	2.9	20.69	6.6	101.8	8.5	66.59	6.2
11-13	150	19.04	3.8	22.80	6.7	105.5	9.5	69.55	7.6
> 13	124	20.55	3.7	26.57	5.7	107.4	9.0	71.01	7.3
Total	**385**	**19.13**	**3.7**	**23.45**	**6.8**	**105.10**	**9.3**	**69.17**	**7.3**
% prevalence		**19.0**		**21.5**		**4.9**		**9.4**	

[1]IOTF age specific cutoffs for BMI, [2] CDC cutoffs, [3] HSBP and HDBP: SBP /DBP value ≥ 95th percentile for respective age, sex and height percentile

Table 1: Mean (± sd) values for BMI, body fat (%) and blood pressure levels.

Odds ratio for risk of overweight and for risk of high blood pressure were computed using logistic regression. All the analysis was carried out using SPSS/PC+ 11.0 for windows.

Results

Mean values for BMI increased (p<0.001) with age in both boys and girls (Table 1). Body fat percent also increased with age (p<0.001) in girls but showed reverse trend in boys. Prevalence of overweight was significantly higher (p<0.001) in boys than girls for both the indicators. Mean values for SBP and DBP also increased with age in both the sexes. The overall prevalence of HSBP was 6.6% in boys 4.0% in girls while that for HDBP was 8.1% and 9.4% respectively. Moreover, prevalence for HSBP and HDBP was examined by tertiles of various indicators used for assessment of overweight (Table 2). The prevalence of high blood pressure increased significantly (p<0.001) from lower tertile to higher tertile of BMI (p<0.01), body fat (p<0.05), central adiposity (subscapular+suprailiac), peripheral (triceps+biceps) adiposity and waist circumference.

Comparison of mean time spent in various activities by overweight and control children showed significant differences (Table 3). Total active time differed significantly (p<0.001) among control and overweight in both sexes. Among the various activities considered, boys spent maximum time in outdoor games, and it was significantly (p<0.001) lower for those who were overweight. They spent relatively less time in exercise, indoor games and in special activities compared to control but the differences were not statistically significant. In contrast, girls spent more time in special activities (like dance, swimming etc.) and it differed significantly (p<0.01) for control and overweight girls. Overweight girls were observed to spent significantly (p<0.001) more time in indoor games compared to their controls. Thus overweight children spent less time in physical activities.

Total inactive time was significantly (p<0.001) higher for overweight compared to control children in both sexes (Table 3) and TV viewing constituted largest part of it. The fact that even the control girls spend relatively higher time in TV viewing supports the above observation that girls prefer to spend time in in-house activities.

Association of physical activity and inactivity with adiposity was examined (Table 4) on pooled sample (n=300). Total active time was (p<0.001) inversely associated with BMI, body fat and prevalence of overweight. Thus, lower the time spent in outdoor games, higher was the BMI (p<0.001), the body fat percent (p<0.001) and the prevalence of overweight (p<0.001). In fact, highest prevalence of overweight was observed among children spending <60 min/d in outdoor games. On the other hand, higher time spent in indoor games was associated with higher body fat percent (p<0.001) and higher prevalence of overweight (p<0.001) but not with higher BMI. In case of special activities, prevalence of overweight was higher if the time spent was less than 15 min/d. However, no trend was observed with BMI or with body fat percent.

Inactivity was significantly associated with adiposity (Table 4). Higher the total inactive time, higher was the BMI, body fat percent and prevalence of overweight (p<0.001 for all). In fact, highest prevalence of overweight was observed among children exceeding total inactive time

Measurements	Tertiles	% HSBP	% HDBP
BMI	Low	3.4	5.4
	Medium	4.6	8.2
	High	9.6	12.3
	p for trend	0.001	0.01
Body fat	Low	3.8	6.9
	Medium	4.7	8.3
	High	8.4	10.6
	p for trend	0.001	0.01
Waist	Low	3.8	6.3
	Medium	3.5	8.3
	High	10.3	11.3
	p for trend	0.001	0.01
Central skin-fold	Low	3.1	6.1
	Medium	4.9	9.2
	High	9.6	10.6
	p for trend	0.00	0.01
Peripheral skin-fold	Low	4.4	6.4
	Medium	5.0	8.6
	High	8.3	11.0
	p for trend	0.001	0.00

Table 2: Prevalence of HSBP & HDBP according to tertiles of indicators of adiposity.

of 240 min/d. TV viewing also showed significant positive association with BMI, body fat percent and prevalence of overweight ($p<0.01$ for all) with highest prevalence observed among children with TV viewing >=120 min/day.

Mean values for skin folds and WC were examined by levels of time spent in activity and in inactivity (Figure 1). Inactive time showed significant increasing trend while active time showed decreasing trend with central adiposity (suprailiac+subscapular skinfold) and WC.

Finally, we examined (Table 5) the odds ratios for risk of overweight as well as for risk of high blood pressure in children engaged in low and high levels of various activities. It can be seen that children spending less time in outdoor games had higher (OR 8.08; CI: 4.8-13.6) risk for overweight. Similar increased risk was also observed for children spending higher time in indoor games (OR 1.6, CI: 1.02-2.70), for those with higher inactivity (OR 7.67, CI: 4.3-13.4) and for those with TV viewing higher than 120 min/d (OR 11.6 CI: 6.3-21.4). However, none of the activities showed significant odds ratios for risk of high blood pressure. Children spending higher time in TV viewing showed marginally significant ($p=0.07$) risk for HSBP (OR 3.53, CI; 0.8-14.3).

Discussion

Persistence of childhood obesity into adulthood has been shown by

Sex	Group	Indoor games		Outdoor game		Exercise		Special activities		TV viewing		Inactivity		Total activity	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Boys	Control (n=96)	13.9	21.4	196.1	65.7	19.6	26.5	13.23	23.3	35.8	39.1	111.8	58.9	229.6	69.1
	OW (n=96)	17.0	22.0	66.0	44.4	18.9	23.8	7.55	13.02	94.4	49.8	218.5	75.9	93.24	50.9
	p value	**ns**		**0.000**		**ns**		**ns**		**0.000**		**0.000**		**0.00**	
Girls	Control (n=54)	10.1	20.9	76.7	41.2	35.5	33.8	68.35	44.0	70.0	37.3	144.1	76.0	180.6	69.16
	OW (n=54)	31.7	39.9	53.5	40.0	23.0	27.0	18.87	25.5	100.0	48.1	215.3	81.6	95.4	55.8
	p value	**0.000**		**ns**		**ns**		**0.00**		**0.000**		**0.000**		**0.00**	

OW= Overweight

Table 3: Average time (min/d) spent in each activity by control & overweight subjects.

Activity	Levels	n	Min/d	BMI (Kg/m^2)	SD	Body fat (%)	SD	% overweight
TV viewing	Low	112	< 60	19.3	2.8	23.6	5.3	27.7
	Middle	63	60-120	19.9	2.9	24.0	5.3	27.0
	High	125	≥ 120	21.9	3.8	26.5	6.4	81.6
	p value			**0.000**		**0.000**		**0.000**
Indoor games	Low	225	<30	20.3	3.3	24.3	5.7	45.8
	Middle	36	30-60	20.9	4.3	25.5	7.2	58.3
	High	39	≥60	21.5	3.6	27.4	5.3	66.7
	p value			**ns**		**0.010**		**0.004**
Outdoor games	Low	108	<60	21.9	3.6	27.0	5.7	78.7
	Middle	52	60-90	21.7	3.2	26.6	5.9	61.5
	High	140	≥90	18.9	2.8	22.6	5.3	23.6
	p value			**0.000**		**0.000**		**0.000**
Exercise	Low	215	<30	20. 6	3.4	25.0	5.8	51.6
	Middle	39	30-45	20.2	4.2	24.4	7.1	46.2
	High	**46**	≥45	20.3	3.3	24.7	5.6	45.7
	p value			**ns**		**ns**		**Ns**
Special activities	Low	188	<15	20.8	3.6	25.1	6.0	58.5
	Middle	26	15-30	20.6	3.5	24.7	5.9	65.4
	High	86	> =30	19. 8	3.0	24.5	5.8	26.7
	p value			**ns**		**ns**		**0.000**
Inactivity	Low	98	<120	18.9	2.8	22.9	5.4	58.5
	Middle	127	120-240	20.7	3.4	24.2	5.8	65.4
	High	75	> =240	22.2	3.7	27.0	6.1	26.7
	p value			**0.000**		**0.000**		**0.000.**
Total activity	Low	104	<100	22.4	3.3	27.8	5.4	89.4
	Middle	99	100-200	20.7	3.5	24.8	5.9	51.5
	High	97	>200	18.2	2.2	22.0	4.9	6.2
	p value			0.00		0.00		0.00

Table 4: Mean BMI, body fat & % overweight according to levels of various activities.

several studies (14-16). The increasing prevalence of childhood obesity and its concomitant health risks justify wide spread efforts towards its prevention. Low levels of physical activity and large amounts of inactivity or sedentary behavior are largely assumed to be causally involved in the etiology of obesity. In view of growing epidemic of non-communicable adult diseases in India, investigations on patterns of physical activity, inactivity and adolescent obesity appear imperative. We observed that overweight children spent significantly lower time in different physical activities, had significantly larger inactive time indicating sedentary behavior. Further, higher time spent in physical activity was associated with lower values of BMI, body fat, skinfolds, waist circumference and prevalence of overweight. In contrast, inactive behavior, especially excess TV viewing was associated with overweight, especially central adiposity and showed marginally significant risk for high systolic blood pressure.

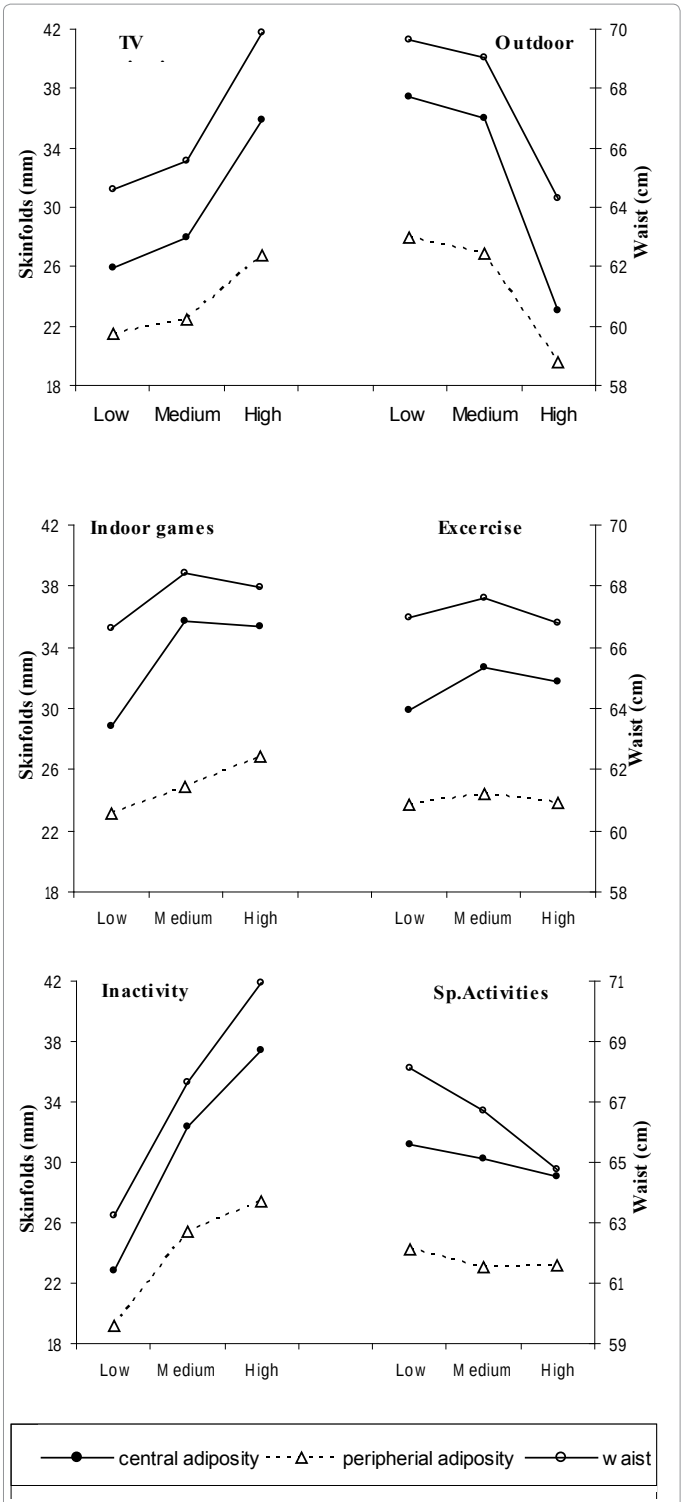

Figure 1: Mean of skinfolds and waist circumference by levels of activity and inactivity.

Activity	Level	Odds Ratio (CI)		
		Overweight	HSBP	HDBP
TV viewing	High vs. Low	11.6** (6.3-21.4)	3.53+ (0.8-14.3)	1.39 (0.2-6.7)
Outdoor games	Low vs. High	8.08 ** (4.8-13.6)	0.91 (0.29-2.9)	2.29 (0.8-6.5)
Special activities	Low vs. High	1.5 (0.9-2.4)	0.76 (0.2-2.3)	0.64 (0.2-1.7)
Indoor games	High vs. Low	1.66* (1.02-2.70)	1.19 (0.3-3.9)	0.61 (0.2-1.6)
Exercise	Low vs. High	1.25 (0.76-2.08)	2.69 (0.6-12.3)	0.70 (0.2-1.8)
Inactivity	High vs. Low	7.67** (4.3-13.4)	1.39 (0.3-5.3)	1.43 (0.4-4.6)

+Marginal significance p=0.07 * p<0.05 ** p<0.01

Table 5: OR's for overweight and HSBP, HDBP according to levels of activity.

It may be worthwhile to consider some of the points before discussing the major findings of our study. Single observation available on blood pressure was the limitation of the study and perhaps may be the reason for higher prevalence of high systolic & diastolic pressures observed in this population. However, it cannot be overlooked that it showed consistent significant association with all the indicators of adiposity. Secondly, measurement of body fat percent by bio-electrical impedance using Omron has some concern but is the best possible option available, especially in field studies. Thirdly, due to constrain on school timings to be spared for the survey, activity questionnaire could be administered only on overweight and their age matched controls randomly selected from the same school. Finally, cut off points for defining HSBP or HDBP used are based on international standards as no such standards are available for Indian or Asian children in general.

The prevalence of overweight observed in adolescents from urban affluent population of Pune is in confirmation with the prevalence reported from other states in India (17). Prevalence of overweight based on body fat cut off was considerably higher than that based on BMI cut off indicates that Indian adolescents have relatively higher body fat for a given BMI (18). Further, prevalence of high blood pressure was significantly higher among children in the highest tertile of BMI, body fat, skinfolds and waist circumference shows health consequences of adiposity even among growing children.

Although, no single method is available to quantify all dimensions of PA (19), it is reported that qualitative aspects may be more important than physical activity related energy expenditure. Therefore,

characterization of physical activity using variety of qualitative and quantitative tools often as self or proxy report is attempted by others (19). Data on time spent in different physical activities collected on overweight and their age matched controls showed that time spent in outdoor games by overweight boys was considerably less compared to their controls while overweight girls spent significantly more time in indoor games. Goran et al (20) have also observed that boys appeared to be engaged in higher levels of PA, report more participation in sports, and have higher levels of aerobic fitness than girls. PA levels decrease as children become older and girls follow this diminishing pattern of activity more than do boys (11). In our study too, time spent in outdoor games by girls above 13 yrs age was considerably less (57 min/d) compared that spent by young girls (73 min/d). Further, despite large observed variations time spent in outdoor games showed the strongest inverse association with BMI, body fat percent and prevalence of overweight. Inverse relationship of PA with adiposity has also been reported by others (21).

Inactivity is commonly measured by surveys with items designed to capture time spent in low activity pursuits. In our study, total inactive time was significantly positively associated with BMI, body fat percent, skinfolds, waist circumference and prevalence of overweight. Children having inactive time more than 240 min/d had significantly higher risk (OR=7.67) for overweight. Role of sedentary behavior in the development of obesity is less developed compared to PA (22). Therefore, our observation that inactive time showed positive association while active time showed inverse association with central adiposity than peripheral adiposity, assumes importance in view of the fact that Asians and in particular Indians have relatively higher abdominal fat for a given BMI compared to a westerner (18). It is reported (23) that although statistically significant relationship exists between inactivity and BMI among children, it is likely to be too small to be of substantial clinical relevance. We too observed a marginal significance (p=0.07) for the risk of high SBP among children with excess TV viewing.

Although the time spent being inactive by our children was likely to be distributed differently among the possible means of inactivity, than among children in United States, obesity does not seem to be associated with < 2 hrs per day of inactivity in any of the countries that have been studied so far (24, 25). A major part of inactive time was that of TV viewing and excess (>120 min/d) television viewing showed significant increased risk (OR=11.58) for overweight. TV viewing has been the most frequently surveyed type of sedentary behavior and has been shown to be associated with obesity (24) in cross sectional studies of children, adolescents and adults (24). However, the cut off for TV viewing above which risk of overweight increases, differs widely (2 to 4 hrs/d) in different studies owing to methodological variations in measurement of TV viewing (self/parental report, in terms of hrs, min, or no of programs and recall of 1 wk or 1 month).

Our observations thus indicate that even among growing children inactivity shows significant association while PA shows inverse association with adiposity and especially with central adiposity. The suggestion is that efforts to reduce problem of over weight through increased PA appear to be encouraging avenue and will have a crucial role in lifelong prevention of obesity. Since protective behaviors as well as risk factors may track into adulthood, it is important to intervene early in life to help formulate good health behavior (6). Public health prevention includes intervention activities that target behaviors and risk factors for obesity in a general population of children and adolescents. Thus provision of play areas and athletic facilities, provision of safe environment for exercise, access to side walks and bike paths are some of the options for promoting PA in children.

Acknowledgement

Dr. Shobha Rao is responsible for planning of the study and writing of the manuscript, Priti Apte is responsible for data verification and actual analysis using SPSS /PC+ 11.0 Window version. This research received no specific grant from any funding agency. There are no conflicts of interest among the authors. The authors are grateful to the Director, A.R.I. for giving Institutional funding for carrying out the study and for providing the necessary facilities. We greatly appreciate the help of other staff member in the Department during the data collection.

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