

Effect of Screen Time, Hours of Physical Activity and Sleep Hours on Overweight and Obesity in School-Going Adolescent Girls of Udaipur

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Abstract

Background: Obesity is one of the most common nutritional problems in developing countries of the world and an important cause of childhood mortality and morbidity leading to permanent impairment of physical and mental growth.

Objective: Effect of screen time, hours of physical activity, and sleep hours on overweight and obesity in school-going adolescent girls of Udaipur.

Materials and Method: The present study was a hospital-based descriptive study, done at the Department of Paediatrics, Geetanjali Hospital, Udaipur, during the term January 2020 to June 2021. A total of 1620 adolescent school-going girls aged 10 years to 18 years were included in the present study after obtaining written informed consent from parents/guardians. They were evaluated on the basis of height and weight and BMI and divided into groups of overweight and obesity on the basis of WHO staging. The detailed history of screen time, physical activity including playing outdoor sports and exercise, and sleep hours were taken along with height, weight, and BMI measurement in case Performa. Statistical analysis was performed using the statistical packages for social sciences (SPSS) version 21 IBM Corporation.

Result: The study presented a statistically significant positive correlation between screen time, hours of physical activity including hours of playing sports and hours of physical exercise, and sleep hours in school-going adolescent girls of Udaipur. Significant overweight and obesity were observed in girls who had screen time of more than 2 hours a day. Significant overweight and obesity were observed in children who had less than 30min of physical activity every day and overweight and obesity were comparable in both groups of girls having sleep hours more or fewer than 8.5 hours a day.

Conclusion: Overweight and obesity are more prevalent in school-going adolescent girls of Udaipur

who had more hours of screen time, fewer hours of physical activity, and more sleep hours.

Keywords: Overweight, Obesity, Body mass index, Screen time, Physical activity, Sleep hours.

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Introduction

In India, obesity as a problem has not been tested even among random groups of people. Numerous studies conducted in major cities of India have shown a significant increase in obesity among school children who belong to richer background status as compared with those from weaker backgrounds[1]. The percentage of obese children who are overweight is 50 to 80% [2] and it is not very easy to fix adulthood obesity than for people in childhood[3].

The sedentary lifestyle of people who are less active is also an important alternative that includes little time for outdoor sports and being part of little or no exercise at all during free time[4,5]. Reasons for childhood obesity are fatty foods, junk, eating more on various social occasions such as birthdays, memorials, family life, television/computer work, unemployment, inadequate play facilities, etc[6,7]. Different definitions have been used in studies to explain childhood obesity and overweight[8,9]. Health care professionals define obesity or increase obesity using BMI or Quetelet Index[10] being a prominent representative of the more direct equator of body fat. BMI is a measure of a person's weight in kilograms divided by a person's height in square meters. Adults with a BMI greater than 30 equate to obesity conditions and those with a BMI of 25 to 30 fall into the category of overweight.

Obesity and overweight in children are defined using the BMI (Body Mass Index) percentile in children over 2 years of age with a BMI over 95th percentile age and the sex of the child is a form of obesity and those children with BMI lying between 85 and 95

percentiles of age and sex of a child fall under the category of overweight[11].

Screen time constitutes an important part of an adolescent's life; adolescents are major TV users[12]. Recent evidence has shown that increased screen-related sedentary behaviors had led not only to obesity growth[13] but also to mental problems among adolescents[14]. Sedentary behavior guidelines recommend less than two hours per day of recreational screen time for youth[15]. However, it has been estimated that more than 50% of adolescents exceed these recommendations for screen-related behaviors[16]. In a report from the Health Behavior in School-Age Children (HBSC), which was performed among adolescents aged 11, 13, and 15 years from 41 countries in Europe and in North America, 56–65% of the adolescents spent 2 h or more per day watching television[17]. Actually, sedentary behaviors are characterized by activities with low energy expenditure (<1.5 metabolic equivalents) in a sitting position like television watching or other screen behaviors[18] and are an important risk factor for cardio-metabolic disease in adulthood[19-22]. In adolescents, obesity is associated with dyslipidemia, glucose intolerance, and hypertension[23].

Materials And Methods:

Objectives: Effect of Screen Time, Hours of physical activity, and sleep hours on overweight and obesity in school going adolescent girls aged 10-18 years in Udaipur.

Study design: The present study was a school-based cross-sectional study, done at

the Department of Paediatrics, Geetanjali Hospital, Udaipur, during the term January 2020 to June 2021.

Inclusion criteria:

1. Clinically diagnosed cases of overweight and obesity (greater than 85% percentile of BMI)
2. Age between 10 to 18 years

Exclusion criteria:

1. Adolescent girls suffering from any other clinically diagnosed illness that is chronic in nature
2. Refusal of Consent

Consent: The ethical approval for the study was obtained from the institutional ethics committee. Informed written consent was sought from parents of eligible children before the commencement of the study. After explaining about purpose of the study, the outcome, and explaining that respondents can refuse and withdraw from the study at any time. All related information was conveyed in the local language.

Method of the study: A total of 1620 school-going girls aged 10 years to 18 years were included in the present study after obtaining written informed consent from parents/guardians. The height, weight, and BMI of these girls were calculated as per WHO guidelines, and detailed history was obtained on their daily screen time, physical activity during the day, and hours of sleep.

Statistical analysis: Statistical analysis was performed using the statistical packages for social sciences (SPSS) version 21 IBM Corporation. Data was entered into MS Excel software. Statistical analysis of Categorical variables was compared between patients using the chi-square test. Quantitative data was analysed using the student T-test. A p-value <0.05 is considered to be significant.

Results:

The study group consisted of 1620 school-going adolescent girls of Udaipur. Schools were randomly selected from urban and rural schools, located within the city and near the city.

Table 1: Distribution of girls according to Body Mass Index (BMI)

BMI	No. of Girls	Percentage
<85 Percentile	1315	81.2%
85-95 Percentile	229	14.1%
>95 Percentile	76	4.7%
Total	1620	100.0%

The table shows the distribution of girls according to Body Mass Index (BMI). Out of a total of 1620 girls included in our study, 1315 (81.2%) are below the 85th percentile of BMI, 229 (14.1%) are in the 85th-95th percentile of BMI, and 76 (4.7%) are in the >95th percentile range of BMI.

Table 2: Age-wise distribution of girls as Overweight and Obese

Age (years)	BMI			Total	% Of Overweight	% Of Obese
	<85 th percentile	85 th - 95 th percentile	>95 th percentile			
10	202	23	12	233	9.8	5.2
11	195	15	7	230	6.5	3.0
12	135	15	7	157	9.5	4.5
13	145	35	4	184	19.0	2.2
14	140	14	10	164	8.5	6.1
15	132	34	4	170	20	2.4

16	134	33	3	170	19.4	1.8
17	140	35	10	185	18.9	5.4
18	92	25	10	127	19.6	7.9
Total	1315	229	76	1620	14.1	4.7

Table and shows the age-wise distribution of girls as Overweight and Obese according to BMI. In our study max percentage of overweight and obese girls were seen in the age group 15 years (20 %) and 18 years (7.9 %) respectively. Whereas minimum no of overweight and obese girls was seen in the age group 11 years (6.5 %) and 16 years (1.8 %) respectively.

Table 3: Distribution of girls according to TV hours into Overweight and Obese

TV hours (>2 hrs/day)	BMI GROUP			Total	% Of Overweight	% Of Obese
	<85 th percentile	85 th - 95 th percentile	>95 th percentile			
No	714	106	34	854	12.4	4.0
Yes	601	123	42	766	16.0	5.5
Total	1315	229	76	1620	14.1	4.7

The table shows the distribution of girls according to TV hours into Overweight and Obese. Out of a total of 1620 girls, 106 girls (12.4%) of those who had tv watching hours of less than 2 hours per day were overweight and 34 girls (4%) of those who had tv watching hours of less than 2 hours per day were obese. Whereas 123 girls (16%) of those who had tv watching hours of more than 2 hours per day were overweight and 42 girls (5.5%) of those who had tv watching hours for more than 2 hours per day were obese.

Table 4: Distribution of girls according to game participation into Overweight and Obese

Games participation	BMI GROUP			Total	% Of Overweight	% Of Obese
	<85 th percentile	85 th - 95 th percentile	>95 th percentile			
No	633	120	44	797	15.0	5.5
Yes	682	109	32	823	13.2	3.9
Total	1315	229	76	1620	14.1	4.7

The table shows the distribution of girls according to game participation into Overweight and Obese. Out of a total of 1620 girls, 120 girls (15.0 %) of those who did not have any active participation in any outdoor activity were overweight and 44 girls (5.5 %) of those who did not have any active participation in any outdoor activity were obese. Whereas 109 girls (13.2 %) of those who had active game participation were overweight and 32 girls (3.9 %) who had active game participation were obese.

Table 5: Distribution of girls according to hours of physical exercise into Overweight and Obese

Physical exercise (>30 min per day)	BMI GROUP			Total	% Of Overweight	% Of Obese
	<85 th percentile	85 th - 95 th percentile	>95 th percentile			
No	402	79	29	510	15.5	5.7
Yes	913	150	47	1110	13.5	4.2

Total	1315	229	76	1620	14.1	4.7
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The table shows the distribution of girls according to hours of physical exercise into Overweight and Obese. Out of a total of 1620 girls, 79 girls (15.5 %) of those who did a physical exercise for less than 30 minutes a day were overweight and 29 (5.7%) of those who did a physical exercise for less than 30 min per day were obese. Whereas 150 (13.5 %) of those who did a physical exercise for more than 30 minutes per day were overweight and 47 (4.2%) of those who did a physical exercise for more than 30 minutes per day were obese.

Table 6: Distribution of girls according to Sleep Hours

Sleep (hrs/day)	No. of cases	Percentage
<8.5 hrs	818	50.5%
>8.5 hrs	802	49.5%
Total	1620	100.0%

The table shows the distribution of girls according to Sleep hours. Out of a total of 1620 girls, 818 (50.5%) have sleep hours less than 8.5 hours and 802 (49.5%) have sleep hours more than 8.5 hours.

Discussion:

Obesity is now widely known as a global epidemic[32]. The WHO has declared obesity as one of the top ten health risks in the world, while it is ranked among the top five in the developed world[25]. 50 to 80 percent of obese children become obese adults. Preventative and stress-reducing measures need to be implemented from an early age and should be emphasized to family members as well. School-based lifestyles and behavioural change strategies, encouraging schoolteachers to actively participate in these activities, engaging school children in regular sports activities, periodic anthropometric testing, and interventions where necessary, and educating parents on the effects of obesity are other measures to prevent the growing epidemic[31]. The current study was taken from 1620 adolescent girls from schools in Udaipur.

In our study of 1620 girls, the highest proportion of girls was under the age of 10 (14.4%), and the lowest number of girls were under the age group of 18 (7.8%). In our study, a high percentage of overweight and

obese girls were identified in the 15 (20%) and 18-year-old (7.9%) age groups respectively. Although a small number of obese girls were seen in the 11-year (6.5%) and 16-year-old (1.8%) age groups, respectively. Joshi J et al.[28] analyzed that 62% of respondents fall within the age group of 16-18 years and 33% of respondents fall within the age group of 13-16 years while only 5% of respondents fall within the age group of 10 years to 12 years. They noted that under the 10 to 12 age group 60 percent of respondents were normal and only 20 percent of respondents were underweight and overweight. It was found that none of the respondents at this stage were obese. Under the age of 13-15, 15.15% of schoolgirls were obese followed by 9.09 percent overweight and 69.69 percent normal but 6.06 percent underweight. Under the age of 16-18, 6.45 percent of school-age girls were obese followed by 17.74 percent who were overweight, and 48.38 percent were found to be healthy while only 27.41 were underweight. Kowsalya T et al.[25] found that the highest prevalence of overweight and obesity was observed at 10-11 (7.82) years followed by 12-13 years (7.26) and 14-15 years (5.79). Janssen et al.[33] stated that over the past two decades, the prevalence of overweight has doubled among children and adolescents. For example, the prevalence of obese school children was 20% in the UK,

15.8% in Saudi Arabia, 15.6% in Thailand, 10% in Japan, and 7.8% in Iran (Z-27,28). The highest prevalence was observed in the current study in 64 the 10–11 age group, followed by 12–13 years and 14–15 years. Kapil et al.[34], Bhatia et al.[35], and Sood et al.[35] also reported that the prevalence of overweight and obesity in upper-class girls in Bangalore was found in 13.1% and 5.0% respectively. Overweight and obesity were slightly higher in the adolescent age group, i.e., 13–15 years old, as seen in other studies in Delhi and Chennai[36], presumably due to increased adipose tissue and whole-body weight in adolescence. The prevalence of overweight and obesity decreased slightly after puberty (16-17 years).

Of the 1620 girls, 818 (50.5%) had less than 8.5 hours of sleep and 802 (49.5%) had more than 8.5 hours of sleep. Also, 126 girls (15.5%) of those who had less than 8.5 hours of sleep a day were overweight and 38 (4.6%) girls who had less than 8.5 hours/day been obese. Although among girls who slept more than 8.5 hours/day, 103 girls (12.8%) were overweight and 38 (4.7%) were obese. Dabade S et al.[27] noted that the prevalence of overweight and obesity was found to be 32.29% higher in the study participants with 7 hours or fewer hours of sleep compared to only 10.98% in those with a sleep duration of >7 h. Of the 1620 girls, 854 (52.7%) watched television fewer than two hours a day and 766 (47.3%) watched more than 2 hours a day. Also, 106 girls (12.4%) of those who had less than 2 hours of TV watching a day were overweight and 34 (4%) of those who had less than 2 hours of TV watching a day were obese. Although 123 girls (16%) of those who had more than 2 hours of TV watching a day were overweight and 42 girls (5.5%) of those who had more than 2 hours of TV watching a day were obese. Bhattacharyya et al.[26] found that leisure hours such as the length of time watching TV/video, listening to music, or reading storybooks were checked for an hour a day. Ninety-three girls (35.8%) enjoy

at least one hour of leisure time a day, 120 (46.2%) enjoy 2 hours/day, 41 (15.8%) enjoy 3 hours/day and 6 (2.3%) enjoy 4 hours/day. Thus, 47 of the 260 girls enjoyed three or more hours of relaxation. Of these 47 girls, 34 (72%) were in the overweight/obese category, and 13 (27.6%) were in the underweight/normal BMI category. This difference was statistically significant ($p = 0.00$). Similarly, Tharkar S et al[36] and Liou et al.[37] reported that teens who watched TV for more than 2 hours were obese. Laxmaiah et al.[38] reported that obesity was significantly lower in children participating in outdoor sports than among non-participants and higher in children watching television for longer periods. Nawab et al.[39] also reported that watching television for more than 2-3 hours a day increases the risk of overweight and obesity. 65 Here, out of a total of 1620 girls, 510 girls (31.5%) exercise for less than 30 minutes a day, while 1110 girls (68.5%) exercise for more than 30 minutes a day. Also, 79 girls (15.5%) of those who exercised for less than 30 minutes a day were overweight and 29 (5.7%) of those who exercised less than 30 minutes a day were obese. Although 150 (13.5%) of those who exercised more than 30 minutes a day were overweight and 47 (4.2%) of those who exercised more than 30 minutes a day were obese.

In addition, out of a total of 1620 girls, 797 girls (49.2%) participated in outdoor sports and 823 girls (50.8%) did not participate in outdoor sports. Also, 120 (15.0%) of those who did not participate fully in any outdoor activity were overweight and 44 (5.5%) of those who did not participate in any outdoor activity were obese. Although 109 girls (13.2%) of those who regularly participated in the sport were overweight and 32 (3.9%) girls who participated in the sport were obese. A study by Bhattacharyya et al.[26] revealed that 67 girls (25.8%) did at least 60 minutes of physical activity per day per week. Sixty-six girls (25.4%), 73 (28.1%), and 54 (20.8%)

girls do the same physical activity for at least 60 minutes a day 2-3 days / week, 4-5 days / week, and 6- 7days / week respectively. Bachani D et al.[40] showed that only 8.8% of boys and 9.2% of girls among Indian youths had daily exercise. A study conducted by the Centre for Disease Control and Prevention, USA reported that 17.7% of women and 36.6% of young male students had a minimum of 60 minutes/day for 7 days[41]. A WHO study found that less than 25% of teens meet the recommended guidelines for 60 minutes of moderate to vigorous exercise[42]. Hossain M et al.[29] noted that the majority (> 80.0%) of overweight/obese children do not participate in school sports or after school. They were less active in helping with household chores and were more exposed to inactive behavior. The publications also highlighted the growing trend of overweight/obesity through urbanization, eating habits, sedentary lifestyles, and high-income economic groups[43-44]. A study by Rahman et al.[45] in English schools also identified eating habits, sedentary lifestyles, and high levels of physical activity as major contributors to obesity.

In our study of a total of 1620 girls included in our study, 1315 (81.2%) were below 85th percentile BMI, 229 (14.1%) were 85th-95th percentile BMI, and 76 (4.7%) in the > 95th percentile range of BMI. A study by Bhattacharyya et al.[26] evaluated, based on BMI criteria, 34.7% were overweight and obese. Shah T et al.[46] reported that based on BMI, of 112 students in Ahmedabad, 34% were found to be overweight and obese and that young women were more overweight. In their study among affluent 12- to 18-year-old English medium girls Mondal A et al.[47] showed that 28.5% were overweight and 4.2% were overweight. A multicentric study by Kumar K et al.[48] reported a disproportionate spread of 20-25% of women (15-49 age group) being overweight and

obese in the slums of Delhi, Mumbai, and Kolkata.

This suggests that the practice of overweight and obesity among school-age girls may be the result of multimedia marketing of a variety of high-calorie foods that appeal to teens. Lack of parental information for slum girls, in terms of measures to prevent[30] obesity and overweight, may also be a factor. Dabade S et al.[27] noted that amongst the 360 participants, the prevalence of overweight was 9.16% and obesity was 2.5%. Of the 185 boys and 175 girls, the prevalence of overweight and obesity was 12.97% for boys compared to 9.14% for girls. In the Vohra et al.[24] study, overweight and obesity were found at 4.17% and 0.73%, respectively, comprising 4.91% of overweight/obesity. Bharati et al.[49] reported the prevalence of overweight and obesity as 3.1% and 1.2% respectively, comprising 4.3% combined. Sethi and Kapoor[50] reported an increase in obesity of 7.8% and 13.4% of Delhi. The frequency variation can be explained due to differences in the basics of the study characteristics as the students were from different provinces with different cultures and eating patterns. In addition, diversity can be explained by differences in the method and conditions used to assess overweight and obesity. Kowsalya T et al.[25] found the prevalence of low weight, normal, overweight, and obesity was found to be 28.31%, 64.82%, 5.18%, and 1.68% respectively.

Conclusion and Summary:

A present school-based cross-sectional study was conducted to assess the prevalence of overweight and obesity and its relation to screen time, hours of physical activity, and sleep hours. A total of 1620 school-going adolescent girls of the age group 10 to 18 years of age were studied.

Prevalence of overweight was 229 (14.1%) and the prevalence of obesity was 76 (4.7%)

in the study population by using the CDC age-specific BMI percentile charts.

The maximum study population from the age group of overweight and obese girls were seen in the age group 15 years (20 %) and 18 years (7.9 %) respectively.

- The prevalence of overweight and obesity was more in girls who had a TV watching hours for more than two hours per day.
- The prevalence of overweight and obesity was more in girls who did not play outdoor games.
- The prevalence of overweight and obesity was more in girls who did a physical exercise for less than 30 minutes a day.
- The prevalence of overweight was more in girls who had fewer sleeping hours but the prevalence of obesity was more in girls who had more sleeping hours.

Recommendations:

Based on this study the following recommendations are made

1. The girls should be encouraged to play outdoor games daily.
2. They should modify their lifestyle in such a way that they should give less time to watching TV and playing video games.
3. They must perform physical exercises in school.
4. They should be encouraged to walk to school or use a bicycle.

References:

1. Gupta AK, Ahmad AJ. Childhood obesity and hypertension. *Indian pediatrics*. 1990 Apr;27(4):333-7.
2. Styne DM. Childhood and adolescent obesity: prevalence and significance. *Pediatric Clinics of North America*. 2001 Aug 1;48(4):823-54.
3. Park K. Park's textbook of preventive and social medicine. *Preventive Medicine in Obstet, Paediatrics, and Geriatrics*. 2005.-319.

4. Varo JJ, Martínez-González MA, de Irala-Estévez J, Kearney J, Gibney M, Martínez JA. Distribution and determinants of sedentary lifestyles in the European Union. *International journal of epidemiology*. 2003 Feb 1;32(1):138-46.
5. Flodmark CE, Lissau I, Moreno LA, Pietrobelli A, Widhalm K. New insights into the field of children and adolescents' obesity: the European perspective. *International journal of obesity*. 2004 Oct;28(10):1189.
6. Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. *Jama*. 1999 Oct 27;282(16):1561-7.
7. Laxmaiah A, Nagalla B, Vijayaraghavan K, Nair M. Factors affecting the prevalence of overweight among 12-to 17-year-old urban adolescents in Hyderabad, India. *Obesity*. 2007 Jun;15(6):1384-90.
8. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000 May 6;320(7244):1240.
9. Guillaume M. Defining obesity in childhood: current practice. *The American journal of clinical nutrition*. 1999 Jul 1;70(1):126S-30S.
10. Adolphe Quetelet EG. the average man and indices of 280 obesity. *Nephrol Dial Transplant*. 2007; 23:47-51.
11. Nelson Book Paediatrics, 20 editions. Chapter-47, Page 307-317 Overweight and Obesity.
12. Domoff, S. E., Sutherland, E., Yokum, S., Gearhardt, A. N. The association of adolescents' television viewing with Body Mass Index percentile, food addiction, and addictive phone use. *Appetite*,2021:157.
13. Throuvala, M. A., Griffiths, M. D., Rennoldson, M., Kuss, D. J. The Role of Recreational Online Activities in School-Based Screen Time Sedentary Behaviour Interventions for Adolescents: A Systematic and Critical Literature Review.

- International Journal of Mental Health and Addiction. 2020.
14. Twenge JM, Martin GN, Campbell WK. Decreases in psychological well-being among American adolescents after 2012 and links to screen time during the rise of smartphone technology. *Emotion*,2018;18,765–80.
 15. Tremblay, M. S., LeBlanc, A. G., Janssen, I., Kho, M. E., Hicks, A., Murumets, K., et al. Canadian sedentary behaviour guidelines for children and youth. *Applied Physiology, Nutrition, and Metabolism*, 2011;36,59–64.
 16. Sisson, S. B., Church, T. S., Martin, C. K., Tudor-Locke, C., Smith, S. R., Bouchard, C., et al. Profiles of sedentary behavior in children and adolescents: The US National Health and Nutrition Examination Survey, 20012006. *International Journal of Pediatric Obesity*,2009;4,353-9.
 17. Currie C, Zanotti C, Morgan A. Social determinants of health and well-being among young people *Health Behaviour in School-aged Children (HBSC): international report from the 2009/2010 survey*. Health policy for children and adolescents. WHO Regional Office for Europe,2012:1–252.
 18. Coombs, N. A., Stamatakis, E. Associations between objectively assessed and questionnaire-based sedentary behaviour with BMI-defined obesity among general population children and adolescents living in England. *BMJ Open*, 2015;5,e007172.
 19. Guillaume, M., Lapidus, L., Björntorp, P., Lambert, A. Physical activity, obesity, and cardiovascular risk factors in children. *The Belgian Luxembourg Child Study II*. *Obesity research*,1997;5,549 – 56.
 20. Burke, V., Beilin, L. J., Simmer, K., Oddy, W. H., Blake, K. V., Doherty, D., et al. Predictors of body mass index and associations with cardiovascular risk factors in Australian children: A prospective cohort study. *International journal of obesity*, 2005;29,15–23.
 21. Martinez-Gomez, D., Rey-López, J. P., Chillón, P., Gómez-Martínez, S., Vicente-Rodríguez, G., Martín-Matillas, M., et al. Excessive TV viewing and cardiovascular disease risk factors in adolescents. *The AVENA cross-sectional study*. *BMC public health*,2010;10,274.
 22. Mota, J., Ribeiro, J. C., Carvalho, J., Santos, M. P., Martins, J. Television viewing and changes in body mass index and cardiorespiratory fitness over a two-year period in schoolchildren. *Pediatric exercise science*, 2010;22,245 – 53.
 23. Franceschin, M. J., da Veiga, G. V. Association of cardiorespiratory fitness, physical activity level, and sedentary behaviour with overweight in adolescents. *Revista Brasileira de Cineantropometriae Desempenho Humano*,2020;22,1–12.
 24. Vohra R, Srivastava J, Vohra A, Bhardwaj P, Srivastava S. Overweight and obesity among school-going children of Lucknow city. *J Fam Community Med*. 2011;18(2):59.
 25. Kowsalya T Parimalavalli R,. Prevalence of overweight /obesity among adolescent girls in Salem District, India. *Indian j health sci*. 2014;7(2):73.
 26. Bhattacharyya M, Sen P, Hazra S, Sinha RN, Sahoo SK, Panda AK. Prevalence of Overweight and Obesity among Adolescent School Girls in Urban Slum of Kolkata. *International Journal of Health Sciences*. 2015;(3):7.
 27. Dabade S, Dabade K. Prevalence of overweight and obesity among school-going children of Satara district, Maharashtra. *Natl J Physiol Pharm Pharmacol*. 2019;(0):1.
 28. Joshi J, Kaur E. Factors Associated with Obesity among School Going Girls of Kumaun Region of Uttarakhand, India. *IntJCurrMicrobiolAppSci*. 2019 Oct 20;8(10):960–7.

29. Hossain M, Luies S, Biswas T. Prevalence and factors associated with overweight and obesity among primary school children (9–14 years) in a selected area of Dhaka, Bangladesh: A cross-sectional study. *Indian J Community Med.* 2020;45(4):429.
30. Tengia-Kessy A, Killenga JN. Prevalence of excess body weight and associated factors among secondary school adolescent girls in northern Tanzania: a cross-sectional study. *Pan Afr Med J [Internet].* 2020 [cited 2021 Dec 27];37. Available from: <https://www.panafrican-med-journal.com/content/article/37/253/full>.
31. Viswambharan JK, Bina T, Raphael L. Prevalence and determinants of obesity among adolescent school children of North Kerala. *Int J Community Med Public Health.* 2020 Jul 24;7(8):3142.
32. Kaur S, Sachdev HP, Dwivedi SN, Lakshmy R, Kapil U. Prevalence of overweight and obesity amongst school children in Delhi, India. *Asia Pac J Clin Nutr* 2008; 17:592-6.
33. Janssen I, Katzmarzyk PT, Ross R. Waist circumference and not body mass index explains obesity related health risk. *Am J Clin Nutr* 2004; 79:379-84.
34. Kapil U, Singh P, Pathak P, Dwivedi SN, Bhasin S. Prevalence of obesity amongst affluent adolescent school children in Delhi. *Indian Pediatr* 2002; 39:449-52.
35. Bhatia V, IAP National Task Force for Childhood Prevention of Adult Diseases. IAP national task force for childhood prevention of adult diseases: Insulin resistance and Type 2 diabetes mellitus in childhood. *Indian Pediatr* 2004; 41:443-57.
36. Tharkar S, Viswanathan V. Impact of Socioeconomic Status on the prevalence of overweight and obesity among children and adolescents in urban India. *The Open Obesity Journal* 2009; 1:9-14.
37. Liou YM, Liou TH, Chang LC. Obesity among adolescents: sedentary leisure time and sleeping as determinants. *J Adv Nurs.* 2010; 66:1246-56.
38. Laxmaiah A, Nagalla B, Vijayaraghavan K, and Nair M. 2007. Factors affecting the prevalence of overweight among 12- to 17-year-old urban adolescents in Hyderabad, India. *Obesity (Silver Spring);* 15:1384-90.
39. Nawab T, Khan Z, Khan IM, Ansari MA. Influence of behavioral determinants on the prevalence of overweight and obesity among school-going adolescents of Aligarh. *Indian J Public Health* 2014; 58:121-4.
40. Bachani D, Sogarwal R, Shukia SK, et al. Dietary practices and physical activity performed by adolescents in the selected districts of India. *Indian Journal of Community Health* 2013; 25:169-175.
41. CDC. Adolescent And School Health /Physical Activity Facts Available from <http://www.cdc.gov/healthy-youth/Physical-Activity-Facts>.
42. WHO - Health For The World's Adolescents [Internet] 2014, available from <http://www.medpagetoday.com/Hematology/Oncology/Anemia/43237>.
43. Khan SH, Talukder SH. Nutrition transition in Bangladesh: Is the country ready for this double burden. *Obes Rev* 2013;14 Suppl 2:126-33.
44. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2014; 384:766-81.
45. Rahman NM, Reza AS, Islam AM, Rahman A, Nath KA. Prevalence of obesity and overweight among English medium school children of Dhaka city in Bangladesh. *J Environ Sci Natural Resources* 2014; 7:63-7.

46. Shah TA, Bhatt RJ, Patel M, et al. Body Mass Index, Dietary Habits, Physical exercise among School going adolescents: A Cross-Sectional Study in Ahmedabad. *Natl J Community Med* 2013; 4:314-17.
47. Mandal A, Mandal G. Prevalence of overweight and obesity among the urban adolescent's English medium schoolgirls of Kolkata, India. *Italian J Public Health*. 2012; 9: 1-5.
48. Kumar K, Sinha RK. Understanding women's nutritional status in urban India: 51. a comparative study of slum and non-slum dwellers. [Internet] International Institute for Population Sciences, Mumbai. 1-20 issues 2009. princeton.edu/papers/91275.
49. Bharati DR, Deshmukh PR, Garg BS. Correlates of overweight and obesity among school-going children of Wardha city, Central India. *Indian J Med Res* 2008; 127:539-43.
50. Sethi M, Kapoor P. Obesity. New Delhi: Voluntary Health Association of India; 2003.