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Distribution of Body Mass Index and its demographic determinants among adolescent girls in urban and rural Coimbatore: A community based analytical cross-sectional study

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Abstract
Background: *Obesity and inactivity have become increasingly prevalent among the adolescent population in India.* ***Objectives:****The primary objective of the present study was to determine the body mass index and waist hip ratio among adolescent girls in urban and rural areas of Coimbatore, Tamil Nadu. We also assessed the demographic determinants of body mass index and waist hip ratio among adolescent girls disaggregated by study settings (urban and rural).* ***Methods:****This was a community based analytical cross-sectional study conducted among adolescent girls, 10 to 19 years of age in the urban (Kalapatti) and rural areas (Idikarai) covered by Sarkarsamakulam Primary Health Centre (PHC) Coimbatore district, Tamil Nadu, India. The sample size was estimated to be 200 adolescent girls – included using non-probability purposive sampling technique.* ***Results:*** *In the present study, 24.0% adolescent girls in urban and 12.0% adolescent girls in rural areas were overweight. The mean difference in body mass index between urban and rural areas was 0.240 (95% CI -0.419 to 0.899; p = 0.473).Majority of adolescent girls included in the present study had waist hip ratio less than 0.80. However, 36.0% adolescent girls from urban and 29.0% adolescent girls from rural areas had moderate or high waist hip ratio. The mean difference in waist hip ratio between urban and rural adolescent girls was 0.002 (95% CI -0.067 to 0.071; p = 0.954).Education, family income and food habits were significantly associated with body mass index of adolescent girls in both urban and rural areas (p<0.05). However, the type of family significantly predicted body mass index of adolescent girls only in urban areas, but not in rural areas.* ***Conclusion:****The most effective approach is to provide education and opportunities both at home and at school, with family involvement and encouraging support from siblings and peers for healthy eating and exercise. By reducing the risk of obesity in adolescent girls, we can enhance pregnancy outcomes and improve the health of future generations.*

Keywords: *Obesity, overweight, body mass index, adolescent girls, India, food habits, waist hip ratio*

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I. Introduction

Adolescence is a transitional period between childhood and adulthood, marked by rapid physical and psychological growth, and development.(1) It is a critical period when individuals form attitudes, beliefs, and opinions, including those regarding their own identity. Globally, over 3 billion people are below 25 years of age, with 1.2 billion being adolescents aged 10-19 years.(2) In India, there are approximately 190 million adolescents, comprising over one-fifth of the population.(3)In recent years, obesity and inactivity have become increasingly prevalent among the adolescent population in India.(4, 5)The National Family Health Survey 5 (NFHS-5) reports documents that 4.2% of Indian adolescents between 15 and 19 years of age are overweight and 1.2% are obese.(6) However, in a recent meta-analysis it was found that the prevalence of overweight was 12.6% and that of obesity was 3.4%.(7) It has been predicted that the prevalence of obesity will reach 6.2% by

2030.(8)In a school based cross-sectional study reported from Bhubaneswar,India, it was found that there is a need for differential strategic plan especially for adolescents from urban settings and private schools.(9) This may be a periodic screening campaign followed by counselling of stakeholders including adolescents, parents, teachers, and administrations using the school health programme platform.(10)

The consequences of overweight and obesity among adolescents are numerous and can have long-lasting effects on their physical and mental health.(11)The physical health consequences include increased risk of type 2 diabetes, cardiovascular diseases including stroke and joint problems (including pain and early development of osteoarthritis). The mental health consequencesinclude low self-esteem and body image issues ultimately leading to distress, depression and anxiety; and risk of bullying (leading to negative individual and social consequences).(12) The long-term health consequences include risk of premature death and increased healthcare costs, leading to economic burden at the family and health system levels.(13)It is important to note that these consequences are preventable with lifestyle changes such as a healthy diet, regular physical activity, and weight management.(14)

The determinants of adolescent obesity include genetic factors and/or positive family history, lifestyle factors (sedentary lifestyles, high-calorie diets, poor sleep habits, low intake of fruits and vegetables), early childhood growth patterns, socio-economic status (adolescents from lower socio-economic backgrounds having limited access to healthy food options, safe places to exercise, and affordable healthcare), food marketing (leading to unhealthy food choices), mental health (depression and/or stress resulting in overeating or other unhealthy behaviours), medical conditions (including polycystic ovary syndrome (PCOS) and hypothyroidism), screen time, neighbourhood and built environment.(15-18) Briefly, improper dietary patterns, unhealthy food habits, and lack of physical activity are the major associated factors that increase the burden of obesity among adolescents. In a study reported from Kancheepuram District of Tamil Nadu, it was found that increased fast food consumption(OR 2.39, 95% CI 1.32 to 4.32), intake of sweets and/or chocolates (OR 4.1, 95% CI 2.04 to 8.24) and inadequate fruit intake (OR 2.01, 95% CI 1.17 to 3.45) were significantly associated with adolescent obesity.(19)In a study reported from a low- and middle-income setting, it was found that overweight and/or obesity among adolescents was directly associated with lower paternal education and unemployment ($p<0.05$).(20)The 2016 India Report Card shows that only 37.5% of adolescents aged 13 to 15 years accumulatedrecommended levels of physical activity – most Indian adolescents do not achieve recommended levels of physical activity and spend most of their day in sedentary pursuits.(21)

It is the need of the hour to compare Body Mass Index (BMI) among urban and rural adolescents because it can help to identify disparities (in the prevalence of overweight and obesity), understand the impact of environment (access to healthy food options and physical activity opportunities), address health inequalities, and evaluate the effectiveness of public health interventions.(22)In conclusion, comparing BMI among urban and rural adolescents is crucial for developing evidence-based public health policies that can improve their overall health and well-being. Against this background, the primary objective of the present study was to determine the body mass index and waist hip ratio among adolescent girls in urban and rural areas of Coimbatore, Tamil Nadu. We also assessed the demographic determinants of body mass index and waist hip ratio among adolescent girls disaggregated by study settings (urban and rural).

II. Materials And Methods

This was a community based analytical cross-sectional study conducted among adolescent girls, 10 to 19 years of age in the urban and rural areas covered by Sarkarsamakulam Primary Health Centre (PHC) Coimbatore district, Tamil Nadu, India.Kalapatti is the urban area covered (four Kilometres from KMCH college of Nursing) and Idikarai is the rural area (14 Kilometres from KMCH college of Nursing).

The adolescent girls 10 to 19 years of age at selected urban and rural areas willing to participate were included in the present study. However, we excluded physically and mentally challenged adolescent girls, adolescent girls having health problems like juvenile Diabetic Mellitusand asthma. We estimated the sample size of the present study to be 200 adolescent girls between 10 and 19years of age – hundred were selected from urban area and hundred from rural area.The total population of the urban area (Kalapatti) was 5372, of which 260 were adolescent girls; and the total population of the rural area (Idikarai) was 4509, of which 193 were adolescent girls. We used non-probability purposive sampling technique to select the study participants.

The study questionnaire was developed by the researcher for the purpose of obtaining data for the study on reviewing literature and in consultation with medical and nursing experts in the field of community medicine and nursing. It was a purpose designed, pilot tested, semi structured questionnaire. The tool was content validated by experts in the field of nursing and medicine – suggestions were considered, and appropriate changes were made. The tool includes questions on demographic variables including age, religion, education, family monthly income, type of family, food habits, number of family members, and parents' education. We measured the height and weight of adolescent girls to obtain body mass index. We also measured waist circumference and hip circumference of adolescent girls to obtain waist hip ratio.The outcome variable body

mass index was categorized as shown in **Table 1**. We conducted a pilot study to understand the feasibility and validity of study procedures. It was conducted at Vellamadai (urban area) and Veeriyampalyam (rural area) under Sarkarsamakulam Primary Health Centre, Coimbatore among fifty adolescent girls, 25 each from urban and rural areas.

The study was implemented after approval from Institute Ethics Committee, KMCH Hospital, Coimbatore, Tamil Nadu, India. We obtained formal permission from the Medical officer,Sarkarsamakulam Primary Health Centre, Coimbatore. The data collection was done for a period of sixweeks. The investigator established a good rapport and introduced the study topic to the adolescent girls.Brief explanation was given to the adolescent girls regarding the purpose of the study.Informed verbal concern was obtained from the participants and assurance was given that the data collected will only be utilized for academic purposes. Each interview including anthropometric measurements took around 20 to 25 minutes.

The data collected was entered in Microsoft Excel and analysed using SPSS v23. We performed both descriptive andinferentialstatistics.Descriptive statistics included estimation of mean, median, standard deviation, and frequency – primarily to describe the demographic data.Inferential statistics included chi square test, Karl Pearson correlation,unpaired "t" test to assess association between the body mass index and demographic variablesof interest in the present study.

III. Results

The study included a total of 200 adolescent girls – 100 each from urban and rural areas. The distribution of demographic variables of adolescent girls in urban and rural areas are presented in **Table 2**. With regard to the age of adolescent girls, 61.0% and 54.0%belonged to urban and rural areas respectively.Considering the religion of adolescent girls, 69.0% and 74.0%were Hindus; 30.0% and 26.0% were Christians in urban and rural areas respectively. In urban areas, only 1.0% were Muslims. Completion of secondary (61.0% vs 58.0%) and higher secondary education (33.0% vs 29.0%) was common in both urban and rural areas, in that order. In urban areas, majority had a monthly family income between Rs.10001 and Rs.20000 (48.0%), followed by between Rs.20001 and Rs.30000 (31.0%). In rural areas, majority had monthly family income between Rs.10001 and Rs.20000 (51.0%), followed by less than Rs.10000 (39.0%).In both urban and rural areas, majority were from nuclear families (76.0% and 73.0% respectively). Joint families constituted 24.0% and 27.0% in urban and rural areas respectively. Regarding the number of family members, 64.0% had two to four members in urban and 57.0% had two to four members in rural areas. Almost all, that is, 93.0% and 96.0% study participants were non-vegetarians in the present study.With regards to parental education of adolescent girls, 95.0% of urban and 98.0% of rural parents were literate.

Majority of the adolescent girls included in the present study had normal body mass index – 69.0% in urban and 75.0% in rural areas. However, we found that 24.0% adolescent girls in urban and 12.0% adolescent girls in rural areas were overweight with a body mass index between 25.0 and 29.9. The mean (SD) body mass index in urban and rural areas were 21.15 (2.46) and 21.39 (2.26) respectively. The mean difference in body mass index between urban and rural areas was 0.240 with a standard error of 0.334 (95% CI -0.419 to 0.899; $p = 0.473$).

Majority of adolescent girls included in the present study had waist hip ratio less than 0.80; 64.0% from urban and 71.0% from rural areas. However, we found that 36.0% adolescent girls from urban and 29.0% adolescent girls from rural areas had moderate or high waist hip ratio. The mean (SD) waist hip ratio of adolescent girls was 0.851 (0.241) and 0.853 (0.25) in urban and rural areas respectively. The mean difference in waist hip ratio between urban and rural adolescent girls was 0.002 with a standard error of 0.035 (95% CI -0.067 to 0.071; $p = 0.954$).

The present study assessed the association between body mass index of adolescent girls and selected demographic variables. Significance was taken for p values less than 0.05. Education, family income and food habits were significantly associated with body mass index of adolescent girls in both urban and rural areas ($p<0.05$). However, the type of family significantly predicted body mass index of adolescent girls only in urban areas, but not in rural areas. The present study also found that age was not a significant predictor of body mass index among adolescent girls ($p>0.05$).

IV. Discussion

With the raising burden of non-communicable diseases, comparing BMI among urban and rural adolescents is crucial for developing evidence-based public health policies that can improve their overall health and well-being.(23) The primary objective of the present study was to determine the body mass index and waist hip ratio among adolescent girls in urban and rural areas of Coimbatore, Tamil Nadu. The demographic determinants of body mass index and waist hip ratio among adolescent girls disaggregated by study settings (urban and rural) were also assessed in the present study.The findings of the present study were consistent with the study reported by Kulkarni Pet al (2014).(24)Majority (53.6%) were in the age group of 15 to 19 years with

the mean (SD) age of 14.2 years (3.1). More than half were females (52.3%). As per WHO growth standards for children between 5 and 19 years, taking BMI for age criteria into account, 70.4% study participants were found to be normal, 28.3% thin and 1.3% overweight and/or obese. Nearly two third (63.7%) study participants were suffering from some sort of morbidities. Mean morbidities rank for subjects with thinness was found to be significantly higher compared with normal and overweight and/or obese subjects. Thinness was found to be the major predictor of morbidity age, sex and residing in rural areas.(24)

The present study found the mean difference in body mass index between urban and rural areas to be 0.240 (95% CI -0.419 to 0.899; p = 0.473). Similarly, the mean difference in waist hip ratio between urban and rural adolescent girls was 0.002 (95% CI -0.067 to 0.071; p = 0.954). Though the results did not highlight a statistically significant difference between urban and rural areas, we found that 24.0% adolescent girls in urban and 12.0% adolescent girls in rural areas were overweight. Also, 36.0% adolescent girls from urban and 29.0% adolescent girls from rural areas had moderate or high waist hip ratio. In the present study education, family income and food habits were significantly associated with body mass index of adolescent girls in both urban and rural areas. However, the type of family significantly predicted body mass index of adolescent girls only in urban areas, but not in rural areas.

This study has brought out specific implications in nursing practice, nursing education, nursing administration and research. The implications for nursing practice includes – understanding the relationship between body mass index and demographic variables (education, type of family, family income and food habits). The present study encourages the nursing personal to educate adolescents regarding the ill effects of increased BMI with a particular emphasis on its predictors. The implications in nursing education includes – the role of demographic factors in development of overweight and/or obesity should be stressed in the nursing education along with the consequences of increased BMI. The nursing students must also teach regarding the benefits of physical activity in weight reduction. The implications in nursing research include – further studies should incorporate the role of other lifestyle factors, psychosocial factors, medical factors as predictors of overweight and/or obesity among adolescent girls.(25-27)

To conclude, providing the chance for adolescents to develop healthy eating and exercise habits can help lower the risk of obesity and allow girls to have a healthier body composition before they become mothers.(28) Involving them in food preparation and choice and teaching them about healthy eating can lead to better eating habits and may affect their food choices during pregnancy and later on in life. Offering opportunities for physical activity and sports, both individually and as a family, can reduce sedentary time, improve metabolic health, and prevent weight gain. The most effective approach is to provide education and opportunities both at home and at school, with family involvement and encouraging support from siblings and peers for healthy eating and exercise. By reducing the risk of obesity in adolescent girls, we can enhance pregnancy outcomes and improve the health of future generations.

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Table 1: Interpretation of Body Mass Index and Waist-Hip Ratio

Body Mass Index – category	**BMI values (kg/m2)**
Under weight	<18.5
Normal weight	18.5 to 24.9
Overweight	25.0 to 29.9
Obese	>30
Health risk as an interpretation of WHR	**WHR values**
Low	0.80 or below
Moderate	0.81 to 0.85
High	More than 0.85

Table 2: Distribution of demographic variables among adolescent girls in selected urban (n = 100) and rural area (n = 100)

Demographic data	**Urban (n=100)**		**Rural (n=100)**	
	f	**%**	**f**	**%**
Age				
10-14years	61	61	54	54
15-19 years	39	39	46	46
Religion				
Hindu	69	69	74	74
Christian	30	30	26	26
Muslim	1	1	0	0
Education				
Primary	6	6	13	13
Secondary	61	61	58	58
Higher secondary	33	33	29	29
Family monthly Income				
<Rs.10000	17	17	39	39
Rs.10001-Rs.20000	48	48	51	51
Rs.20001-Rs.30000	31	31	10	10
Above Rs. 30001	4	4	0	0
Type of family				
Nuclear family	76	76	73	73
Joint family	24	24	27	27
Food habit				
Vegetarian	7	7	4	4
Non vegetarian	93	93	96	96
Number of family members				
2-4	64	64	57	57

5-7	36	36	43	43
Parents education Illiterate Literate	 5 95	 5 95	 2 98	 2 98

Table 3: Distribution of respondents according to the level of Body Mass Index among adolescent girls in urban (n = 100) and rural area (n = 100)

Level of BMI	**URBAN**			**RURAL**		
	f	**%**	**Mean ± SD**	**f**	**%**	**Mean± SD**
Below normal (<18.5)	7	7	21.15 ± 2.46	9	9	21.39 ± 2.26
Normal (18.5 to 24.9)	69	69		75	75	
Overweight(25.0 to 29.9)	24	24		12	12	
Obese (>30)	0	0		0	0	

Table 4: Distribution of respondents according to WHR (Waist Hip Ratio) in urban (n = 100) and rural area (n = 100)

Level of WHR	**URBAN**			**RURAL**		
	f	**%**	**Mean±SD**	**f**	**%**	**Mean±SD**
Low(<0.80)	64	64	0.851 ± 0.241	71	71	0.853 ± 0.25
Moderate(0.80-0.85)	12	12		22	22	
High (>0.85)	24	24		7	7	

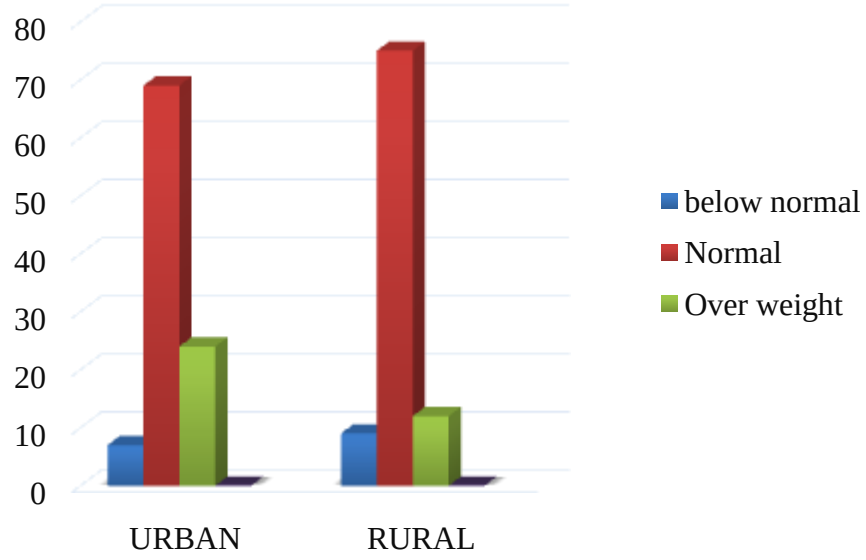

Figure 1: Distribution of respondent according to the level of Body Mass Index

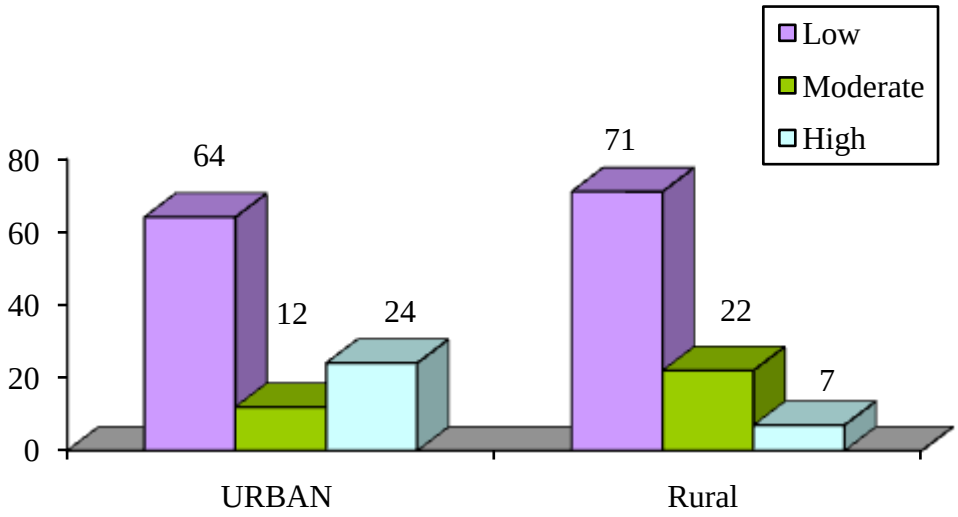

Figure 2: Distribution of Respondent according to the waist hip ratio

Table 5: Association between level of Body Mass Index among adolescent girls in urban and rural area with demographic variables

	URBAN AREA					RURAL AREA				
Demographic variables	**Below Normal**	**Normal**	**Overweight**	**Obese**	**X2**	**Below Normal**	**Normal**	**Overweight**	**Obese**	**X2**
	f	**f**	**f**	**f**		**f**	**f**	**f**	**f**	
Age										
10-15years	4	45	12	0	1.78	6	44	6	0	0.59
16-19years	3	24	12	0		3	35	6	0	
Education										
Primary	2	3	1	0	8.29*	3	5	5	0	9.6*
Secondary	3	49	9	0		3	42	13	0	
Higher Secondary	2	23	8	0		3	23	3	0	
Family income (in Rupees)	1	13	3	0	6.42*	5	18	8	0	13.6*
Less than 10,000	3	35	10	0		4	35	2	0	
Rs.10,001-Rs.20000	2	20	10	0		1	22	2	0	
Rs.20,001- Rs.30,000	1	1	1	0		1	1	1	0	
More than Rs.30,000										
Type of family										
Nuclear	4	45	16	0	6.02*	4	41	4	0	2.50
Joint	4	17	14	0		5	38	8	0	
Food Habits										
Vegetarian	3	52	10	0	10.5*	1	44	7	0	6.1*
Non-vegetarian	4	17	14	0		8	35	5	0	

***p<0.05 significant**