Original Research Article

# A study on evaluation of waist height ratio as a screening tool for obesity

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## Abstract

**Introduction:** Childhood obesity has become a single marker for children at risk for development of various non-communicable diseases later in life. This study is conducted to estimate the prevalence of obesity and the risk factors associated with it and to evaluate Waist Height Ratio (WHtR) as a screening tool to identify obesity in children. **Materials and Methods:** Across sectional study of children between 10 and 15 years of age from upper socioeconomic class from 2 urban schools. **Results:** The prevalence of obesity is 11.7% and prevalence of asymptomatic hypertension is 12%. The Waist height ratio is more than 0.5 in 21.2%. About 50.5% of obese and 40.5% of overweight children had a WHtR of >0.5. Waist Height Ratio correlated significantly with all 5 risk factors taken for the study. **Conclusion:** The prevalence of obesity in children between 10 to 15 years of age in this study is 11.7%. The Waist Height Ratio correlated significantly with the risk factors. Larger studies specific to Indian children are needed to make a clear cutoff value for WHtR to improve the sensitivity of screening.

**Key words:** Obesity, Hypertension, BMI, Waist Height Ratio.

## Introduction

World Health Organization (WHO) describes global obesity as an epidemic affecting at least 300 million people, with raise in 3 fold since 1980 [1]. In 1998, WHO declared obesity as a global epidemic in view of increasing incidence of obesity and its co-morbidities [1]. In 2000, the world-wide number of obese people exceeded the number of underweight people [1].

Childhood obesity has become a single marker for children at risk for development of various non-communicable diseases later in life. The co-morbidities of obesity include coronary heart disease, hypertension (HTN), dyslipidemia, stroke, cancers, NIDDM (Non-Insulin Dependent Diabetes Mellitus), gall bladder disease, osteoarthritis, gout and sleep apnea. Besides, the obese children go through social bias and discrimination making them reluctant to seek medical assistance. There are several risk factors like sedentary life style, high caloric dense diets, behavior changes because of increased urbanization and the regression of traditional life style patterns. Genetic and familial factors also contribute to obesity [2]. The factors associated with idiopathic obesity are numerous – age, sex, race, ethnicity, screen time, energy imbalance, junk foods, sleep hours, etc. The causes for endogenous obesity are also numerous – endocrine, drug intake, tumors, etc. So far 600 genes have been identified to be associated with obesity. Childhood obesity is defined as BMI (Body Mass Index) of more than 95th percentile for age and sex [3]. Childhood overweight is defined as BMI of more than 85th percentile for age and sex [3].

BMI is most commonly used to assess weight, and is a dependable marker for adiposity [4]. BMI correlates with body fat as determined by both skin fold thickness measurement and by densitometry. Thus, it is a reasonable criterion for determining obesity in children and adolescents [5]. Various methods are available to assess obesity like BMI, Waist Circumference, Waist Hip Ratio, Waist Height Ratio, Skin fold thickness, Dual energy X-ray Absorptiometry, etc. The aim of this study is to estimate the prevalence of obesity among school going children between 10 to 15 years, to assess the risk factors associated with them and to evaluate the Waist Height Ratio (WHtR) as a screening tool for obesity.

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## Materials and Methods

A cross sectional study was conducted in 2 schools after taking clearance from ethical committee. The inclusion criteria are to evaluate all Children between the age group of 10 -15 years belonging to upper socio-economic status as per Modified Kuppusamy Classification. Children below 10 years and above 15 years and children diagnosed to be obese due to endogenous causes based on past medical history and clinical examination was excluded. The height was measured using sliding Stadiometer with an accuracy of 0. 1mm.Weight was recorded using electronic weighing scale calibrated to 0.05kg accuracy. Body Mass Index (BMI) was calculated from height and weight. Children were categorized as Normal, Overweight, obese and underweight based on BMI as per National Center for Health Statistics (NCHS) guidelines with respect to their age and sex. Resting Blood Pressure (BP) was determined using mercury manometer with appropriately sized cuffs. Hypertension is defined as average systolic or diastolic BP $\geq$ 95$^{th}$ percentile for age, sex and height, measured on 3 separate occasions [6]. Elevated BP was confirmed on repeated visits before characterizing an individual as having HTN, because of the accommodation effect (anxiety induced changes in BP). A stretch resistant tape was used to measure waist and hip circumference. Waist circumference was taken at midpoint between the crest of the iliac bone and the sub costal margin in the mid axillary line. Hip circumference was taken at the largest circumference of the buttocks. To analyze the life style factors and dietary habits in obese and non-obese groups, a pre-tested proforma was designed and explained to each individual parent and was asked to collect data regarding the child's dietary pattern including food given in between meals and snacks for a period of 3 days, when the child was healthy. Later, the mean calorie intake of each child was calculated and compared with normal calorie requirement of the child for age and sex and was entered in the proforma as normal, caloric excess or caloric deficit. Child's physical activity (outdoor activity) and T.V viewing / video games/ computer games were also recorded in minutes per day for 3 consecutive days including one Sunday, when the child was healthy.

## Results and Analysis

The results are tabulated in tables 1, 2 and 3. There were 1011 children in the study group. Out of 1011 children included

**Table-1: Profile of children in study group**

| | No | % |
|---|---|---|
| **Age distribution** | | |
| 10 years | 132 | 13.1 |
| 11 years | 90 | 8.9 |
| 12 years | 217 | 21.5 |
| 13 years | 209 | 20.7 |
| 14 years | 231 | 22.8 |
| 15 years | 132 | 13.1 |
| **Sex distribution** | | |
| Boys | 463 | 45.8 |
| Girls | 548 | 54.2 |
| **BMI distribution** | | |
| Under Nutrition | 82 | 8.1 |
| Normal | 594 | 58.8 |
| Over weight | 217 | 21.5 |
| Obese | 118 | 11.7 |
| **Waist height ratio** | | |
| < 0.5 | 796 | 78.73 |
| > 0.5 | 215 | 21.27 |
| **Blood pressure** | | |
| Normal | 889 | 87.9 |
| Hypertension | 122 | 12.1 |
| **Waist circumference** | | |
| < 90th centile | 881 | 87.1 |
| > 90th centile | 130 | 12.9 |

in the study, 54.2% were male and 45.8% were female children. In the study group the overall prevalence of overweight and obesity was 21.5% and 11.7% respectively. There is no statically significant difference in gender distribution for obesity and overweight.

There is a simple linear progression in caloric intake in normal weight, overweight and obese children. About 13.2% of normal weight children 65.1% of overweight and obese children had excess caloric intake. Junk food intake or sweetened beverages of more than 2 servings per week (around 280 kcal) was taken as risk as per AAP guidelines.

**Table-2: Profile of children in study group.**

| | Under nutrition | Normal | Overweight | Obese | |
|---|---|---|---|---|---|
| **Age distribution** | | | | | |
| 10 years | 20(24.39%) | 70(11.98%) | 57 (43.1%) | 18(13.6%) | |
| 11 years | 14(17.07%) | 88(15.06%) | 16(17.7%) | 10(11.1%) | |
| 12 years | 15(18.29%) | 106(18.15%) | 42(19.3%) | 50(23%) | |
| 13 years | 12(14.63%) | 125(21.4%) | 49(23.4%) | 27(12.9%) | |
| 14 years | 13(15.85%) | 102(17.46%) | 33(14.2%) | 13(5.6%) | |
| 15 years | 8(9.75%) | 93(15.92%) | 20(15.1%) | 0 | |
| **Gender distribution** | | | | | |
| Male | 66(12%) | 300(55%) | 58(11%) | 66 (12%) | |
| Female | 16(3.5%) | 294(63.4%) | 60(13%) | 16 (3.5%) | |
| **Caloric intake** | | | | | |
| Mean caloric intake | 1560Kcal | 1907 Kcal | 2106 Kcal | 2211 Kcal | P value <0.15 |
| Caloric excess | 0 | 89 | 143 | 75 | <0.05 |
| **WHtR** | | | | | |
| <0.5<br>>0.5 | 75(91.46%)<br>7(8.64%) | 539(90.74%)<br>55(9.26%) | 129(59.44)<br>88(40.56) | 53(44.91%)<br>65(55.09%) | <0.05 |

In our study 36.9% of normal weight, 79.3% of overweight and 90.7% of obese children comes under risk. As per AAP recommendation, physical activity of less than one hour per day is considered to be a risk factor for obesity. In the study among risk group of reduced physical activity 57% were in non-obese group and 82% belonged to obese and over weight group taken together.

Sleep duration of less than 6 hours is considered as risk factor for obesity. In our study 64.2% of overweight and obese group had reduced sleep duration as compared to 22.5% of non-obese group. Screen time is the time spent in television viewing, videogames, social networking sites etc.

Screen time of more than 2 hours per day is considered as risk. In our study 38.8% of obese & overweight children and 9.65% of non-obese group come under risk group. In our study the prevalence of asymptomatic hypertension is 12%. Systolic or diastolic BP $\geq 95^{th}$ percentile for age, sex and height is taken as hypertension.

About 24.9% of overweight and 50% of obese children had associated hypertension. The incidence of hypertension correlates significantly with obesity.

**Table-3: Correlation with the risk factors and BMI.**

| | Undernourished | Normal | Overweight | Obese | P value |
|---|---|---|---|---|---|
| **Junk food intake** | | | | | |
| No risk | 74(90.2%) | 375(63%) | 45(20.7%) | 11(9.3%) | <0.05 |
| Risk | 8(9.8%) | 219(36.9%) | 172(79.3%) | 107(90.7%) | |
| **Physical activity** | | | | | |
| No risk | 41(50%) | 253(42.6%) | 56(25.8%) | 4(3.4%) | <0.05 |
| Risk | 41(50%) | 341(57.4%) | 161(74.2%) | 114(96.6%) | |
| **Sleep duration** | | | | | |
| No risk | 66(80.5%) | 448(75.4%) | 77(35.4%) | 43(36.4%) | <0.05 |
| Risk | 16(19.5%) | 146(24.5%) | 140(64.5%) | 75(63.5%) | |
| **Screen time** | | | | | |
| No risk | 72(87.8%) | 539(90.8%) | 136(62.7%) | 78(66.1%) | <0.05 |
| Risk | 10(12.2%) | 55(9.2%) | 81(37.3%) | 40(33.9%) | |
| **Hypertension** | | | | | |
| Normal | 82(100%) | 585(98.5%) | 163(75.1%) | 59(50%) | <0.05 |
| Hypertension | 0 | 9(1.5%) | 54(24.9%) | 59(50%) | |
| **WHtR** | | | | | |
| <0.5 | 75(91.4%) | 539(90.7%) | 129(59.5%) | 53(44.9%) | <0.05 |
| >0.5 | 7(8.6%) | 55(9.3%) | 88(40.5%) | 65(55.1%) | |

Waist height ratio >0.5 is considered as a risk factor for central obesity. WHtR<0.5 is taken as no risk. Among 1011 children, 215 (21.2%) of the study population are with WHtR>0.5. About 40.5% of overweight children and 55.5% of obese children in the study group had WHtR>0.5. WHtR correlates significantly with obesity. About 34.9% of children with WHtR >0.5 had hypertension, while hypertension occurs in 6% of children with WHtR >0.5. About 83.7% of children with WHtR >0.5 had reduced physical activity. Thus waist height ratio >0.5 correlates with reduced physical activity. Sleep duration of less than 6 hours is considered as risk factor. From our study (129) 60% of children with WHtR >0.5 had reduced sleep duration. According to AAP, waist circumference > $90^{th}$ percentile is a significant risk factor of central obesity. In the study population, 87.1% of children are with waist circumference <$90^{th}$ percentile, while 12.9% of children have central obesity >$90^{th}$ percentile.

## Discussion

Obesity has become a pediatric public health problem associated with risk of complications in childhood and increasing morbidity and mortality in adulthood. The prevalence of childhood obesity keeps increasing due to changes in eating pattern [7], sedentary life, increased junk food intake and sweetened beverages, reduced participation in outdoor sports activities, addiction to television viewing, video games, social networking sites, etc.Thus, obesity in children has emerged as an important focus in pediatric research and practice.

The prevalence of obesity among school children varies from least of 2.5% in Africa to a maximum of 30% in developed countries like United States.In our country the prevalence of obesity varies in urban and rural population, also in various socioeconomic classes [8]. This study is conducted in two private urban schools in Salem district belonging to higher socio-economic class. The prevalence of overweight and obesity is 21.5% and 11.7% respectively in the present study. The prevalence of obesity in the other studies varies from 3.56% to 16%. There was no significant difference in gender distribution. It is comparable to the prevalence in developed countries like America. This is probably due to the fact that the sample population is derived from two urban schools in the upper socio-economic class [9].

The prevalence of asymptomatic hypertension is 12%, increases progressively with the increase in BMI [10].

The prevalence of hypertension in other studies was about 4.5%. In our study 24.9% of overweight and 50% of obese children had associated hypertension. Thus, in the present study the prevalence of asymptomatic hypertension is significantly higher correlatin1g with the increasing prevalence of obesity.

From our study 13.2% of normal weight children 65.1% of overweight & obese children had excess caloric intake. Mean caloric excess intake correlated significantly with obesity. In our study 36.9% of normal weight, 79.3% of overweight and 90.7% of obese children comes under risk. Increased junk food intake is a risk factor which correlates significantly with Obesity [11]. In our study, 57.4% of normal weight, 74.2% of overweight and 96.6% of obese children had reduced physical activity of less than one hour. Correlation between reduced physical activity and obesity is significant in our study.In a cross sectional study by Hazzaa Al Hazzaa et al [12], conducted among children of 15 to 19 years of age in Saudi Arabia, reduced physical activity correlates with obesity. Reduced sleep duration is seen in 24.5% of normal weight, 64.5% of overweight and 63.6% of obese children. Correlation with reduced sleep duration of less than six hours and obesity is significant with a p value <0.05. There was a temporal association between reduced sleep duration and obesity as per the 13 year prospective study conducted in US by gregor et al[13].

In our study 38.8% of obese & overweight children spent screen times of more than two hours while its 9.65% in non-obese group. A *cross sectional study done at New Zealand, by Irene Braithwaite el al[14],* there was a positive correlation of television viewing and obesity [15][16]. WHtR is also a marker of central obesity when compared to BMI. Among 1011 children, 215(21.2%) of the study population had WHtR>0.5. In the present study, WHtR is also a good indicator of central obesity as 40.5% of overweight children and 55.5% of obese children had significant risk as WHtR>0.5. Weight height ratio correlates significantly with obesity with ap value of <0.05. According to a study done in UKby Ma Carthy el al[17], waist height ratio is an important marker for central obesity.

In our study, 34.9% of children with WHtR> 0.5 had hypertension, while hypertension occurs in 6% of children with WHtR<0.5. Based on the cross-sectional study by Michael Khoury et.al [18] abnormal waist height ratio is related to cardio metabolic risk factors in children. In our study, 83.7% of children with WHtR>0.5 had reduced physical activity. Correlation between WHtR and reduced physical activity is significant with p value < 0.5. Waist height ratio correlated well with sleep duration in the study. Correlation is significant as 60% of children with WHtR>0.5 had reduced sleep duration.

Thus WHtR correlates well with all risk factors. Hence it can be used as a screening tool to identify central obesity and other co-morbid conditions like hyper-tension [19]. In this study only 50.5% of obese and 40.5% of overweight children had a WtHR of >0.5. In a study by Seeja et al in 2013, it was suggested that a WHtR of >0.48 can be used to improve the sensitivity in screening obese and overweight children in India [20]**.** Hence larger studies specific to Indian children are needed to make a clear cutoff value of WHtR to improve the sensitivity of screening.

## Conclusion

The prevalence of obesity in the study is 11.7% and prevalence of overweight is 21.5% in the study. The overall prevalence of asymptomatic Hypertension in the study population was 12%. The prevalence of Hypertension among obese children was 50% as compared to 9.1% in normal weight children. The obese children had a statically significant correlation with risk factors of Mean Caloric Intake Excess, Junk food Intake, Reduced Physical Activity, Increased Screen Time and Reduced Sleep duration.

There is a growing consensus by the researchers worldwide to accept the Waist Height Ratio as the important screening tool for Central Obesity in children. In this study we analyzed the usefulness of Waist Height Ratio as a screening tool for obesity and found it to be significantly correlating with BMI. Further Waist Height Ratio also significantly correlates with risk factors like Mean Caloric Intake Excess, Junk food Intake, Reduced Physical Activity, Increased Screen Time and Reduced Sleep duration. Larger studies specific to Indian children are needed to make a clear cutoff value for WHtR to improve the sensitivity of screening. The policy makers and parents should keep in mind the risk factors associated with obesity and formulate a healthy life style for the younger generation to eliminate these risk factors. A public health campaign of '*keep the waist less than half of your height*' will make significant impact in the mindset of people.

**Limitations of the study**: This study is conducted in two urban schools in which may not be representative of entire community.

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