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Prevalence of Obesity by Waist to Height Ratio and Body Mass Index: Comparative Study

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ABSTRACT

Objective of the study was to determine the prevalence of Obesity by Waist to Height Ratio and Body Mass Index. Weight, height and waist circumference were measured in 500 primary school children. Body Mass Index and Waist to Height Ratio were calculated. Categorization of children on the basis of weight, height and Body Mass Index was done. Prevalence of Obesity was determined at Waist to Height Ratio cut offs of 0.48 and 0.5 and compared with Body Mass Index. Prevalence of Obesity as per Body Mass Index was 16.17% in boys and 12.07% in girls. At Waist to Height Ratio cut off of 0.5, 18.72% of boys and 24.9% of girls were obese and at Waist to Height Ratio cut off 0.48, 31.06% of boys and 39.24% of girls were obese. When validated against Body Mass Index, sensitivity and specificity of Waist to Height Ratio at 0.5 cut off were 41.43% and 81.16% respectively and at 0.48 cut off were 55.71% and 67.91% respectively. Hence, Waist to Height Ratio of cut off 0.48 may be employed a useful screening test for Obesity in primary school children.

Keywords: Obesity, Body Mass Index, Waist to Height Ratio, primary school children.

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INTRODUCTION

Obesity is an emerging problem in our community, thanks to junk food, video games and sedentary life style. In the past 30 years, childhood Obesity has more than tripled ^[1]. Body Mass Index (BMI) or Quetlet index, named after its discoverer eliminates the confounding effects of height on weight. BMI is a standard tool for judging the body weight and amount of fat. Even though BMI is not a direct measure of body fat, it is considered the Gold Standard surrogate for the estimation of body fat. ^[2]. It is a better predictor of health risks than body weight alone. Increased BMI indicates increased risks of cardiovascular disease, hypertension, insulin resistant Type 2 diabetes mellitus, sleep apnea and asthma ^[3]. Decreased BMI indicates compromised immune function, higher risks of gastrointestinal tract infections, respiratory tract infections, increased falls and fractures, cancer, osteoporosis and liver problems ^[3, 4]. But BMI does not differentiate between muscle mass and body fat. Hence, persons with high BMI (competitive athletes and body builders) due to relatively larger muscle mass and pregnant or lactating women should not be disturbed if their BMI is not within the normal range ^[5]. Persons with physical disability may have muscle wasting, erroneously reflected as low BMI.

On the other hand, Waist to Height Ratio (WHtR) is an index which differentiates between muscle mass and body fat. Hence, WHtR predicts cardiovascular disease, hypertension and type 2 diabetes mellitus more specifically than BMI ^[6]. It is globally applicable to different ethnic populations and to children and adults ^[7]. Diet modifications and life style changes will reduce the risks in later life. With the use of WHtR, cut off of 0.5 was recommended for both adults and children based studies done by Lucy M Browning et al and Margaret Ashwell et al ^[6, 8]. However, those studies were done largely on non-Asian population. On the other hand, studies done by Weili Y et al and S.T.Panjikaran suggest that 0.48 is more sensitive cut off for Asian population ^[9, 10].

In the present study, we have estimated the prevalence of Obesity and more sensitive cut off of WHtR for the prediction of Obesity in primary school children of South India, keeping BMI as the Gold Standard for predicting Obesity.

MATERIALS AND METHOD

A comparative prospective study was undertaken on a sample size of **500** students of private, government and government aided primary schools belonging to the age group of 5 to 10 years, from August 2013 to September 2013 in Tirunelveli, Tamil Nadu, India. Children with known chronic heart disease, end stage renal disease, chronic respiratory disease, endocrine disorders, major congenital anomalies and inborn errors of metabolism were excluded. Age, gender, birth

order, family size, type of meals, snacks, chicken intake, TV viewing and playing outdoor games were the variables which were also considered in the present study. Although socioeconomic status was not taken as a variable, all strata of society were covered in the present study, as the study sample comprised of an equal number of children from the government sector and private sectors. Children of parents belonging to lower income groups are likely to be enrolled in government schools and those of parents belonging to higher income groups are likely to be enrolled in private schools.

Weight was measured by a standard electronic weighing machine (up to 0.1kg accuracy). The weighing machine was placed on a level, uncarpeted surface. Before each measure, it was made sure that the scale reads zero. The student was asked to remove heavy outer clothing, purses, shoes, any heavy accessories and everything from their pockets. The student was asked to step on the machine and stand motionless in the middle of the machine with feet slightly apart and the body weight distributed equally on both feet. Arms were relaxed and hanging down loosely at the sides of the body. The student was asked to stand very still and head facing straight in Frankfurt Horizontal plane. The weight displayed was read and recorded immediately.

Height was measured by a stadiometer (up to accuracy of 0.1cm). The student was asked to stand back against the board. Body weight was evenly distributed on both feet. Arms hung freely by the sides of the body, palms facing the thighs. Legs were placed together, bringing knees or ankles together. The student was asked to stand erect; head was up and facing straight ahead in Frankfurt Horizontal plane. The student was asked to inhale deeply, holding his or her breath without moving the head or body. The headpiece was brought down to the uppermost point on the head; the hair was compressed and the height was measured.

Waist circumference was measured by a non-stretchable plastic tape at the midpoint between the lower border of the rib cage and the iliac crest.

BMI was calculated using the formula, Weight in kg / (Height in m²). WHtR was calculated using the formula, Waist circumference in cm / Height in cm. Categorization of children on the basis of weight, height and BMI was done, based on Agarwal growth charts for Indian children.

WHtR at cut offs of 0.48 as well as 0.5 were validated against BMI by calculating sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV). Statistical Techniques namely Pearson correlation method, Pearson chi square test and Independent sample t-test were done. The level of significance for Pearson chi square test and Independent sample t-test was kept as 0.05.

RESULTS AND DISUCSSION

Prevalence of Obesity as per BMI is 16.17% in boys and 12.07% in girls. At WHtR cut off of 0.5, a significant proportion i.e. 18.72% of boys and 24.9% of girls were found to be obese. At WHtR cut off 0.48, a more significant proportion i.e. 31.06% of boys and 39.24% of girls were found to be obese. WHtR was validated against BMI at cut offs of 0.5 and 0.48:

		BMI	
		+	-
0.48	+	39	138
	-	31	292

		BMI	
		+	-
0.5	+	29	81
	-	41	349

WHtR at 0.48 cut off

Sensitivity = 55.71%

Specificity = 67.91%

PPV = 22.03%

NPV = 90.4%

WHtR at 0.5 cut off

Sensitivity = 41.43%

Specificity = 81.16%

PPV = 26.36%

NPV = 89.48%

In the present study, WHtR cut off of 0.48 was found to be more sensitive whereas WHtR cut off of 0.5 was found to be more specific in South Indian children. Since Obesity has serious complications in later life, it is prudent to use a more sensitive cut off of WHtR i.e.0.48, in order to pick up all true positives.

WHtR had a positive correlation of 0.720 and 0.507 with BMI in private and government school children respectively (Pearson correlation).

There was a statistically significant difference between the BMI of private and government sector children. There was also a statistically significant difference between the WHtR of private and government sector children (Independent sample t-test).

Variables considered were age, gender, birth order, family size, type of meals, snacks, chicken intake, TV viewing and playing outdoor games. Only some of these variables were found to statistically significantly influence the BMI and WHtR at a cut off of 0.48 whereas almost all variables were found to significantly influence the WHtR at a cut off of 0.5 (Pearson chi square test).

DISCUSSION

Among the 500 primary school children studied, a significant percentage of children i.e. 14% were found to be obese as per BMI. As high as 22% and 35.2% of children were found to be obese as

per 0.5 and 0.48 cut offs of WHtR respectively [Table–I, Fig.1,2&3] which was found to have a positive correlation of 0.720 and 0.507 with BMI for private and government school children respectively [Table–II & III]. Lucy M Browning et al, in a systematic review of WHtR as a screening tool for the prediction of cardiovascular disease suggested that 0.5 could be a suitable global boundary value for adults and children [6]. Similar results were obtained by Margaret Ashwell et al, in a study of WHtR as an indicator of early health risk [8]. However, Weili Y et al, in a study of accuracy of WHtR concluded that WHtR at cut off of 0.48 was a very sensitive indicator of Obesity in school children [9]. According to S.T.Panjikaran WHtR cut off point is population specific and for children from south India, the optimum cut off point is 0.48 [10].

In the present study, WHtR was validated against BMI at 0.5 and 0.48 cut offs. Sensitivity and specificity of WHtR at 0.5 cut off were found to be 41.43% and 81.16% respectively with a PPV of 26.36% and a NPV of 89.48%. Sensitivity and specificity of WHtR at 0.48 cut off were found to be 55.71% and 67.91% respectively with a PPV of 22.03% and a NPV of 90.4%. Though BMI is the Gold Standard test for Obesity, WHtR may pick up more children with a future tendency to Obesity, as WHtR is a measure of central deposition of fat, a definite predictor of cardio metabolic risk. From the present study, it is inferred that WHtR of 0.48 cut off is more sensitive whereas WHtR of 0.5 cut off is more specific. However, it is prudent to apply a more sensitive cut off of WHtR i.e.0.48 to plan nutritional intervention and life style modification in all children who are truly obese, so as to prevent the inherent complications of Obesity in later life.

Prevalence of Obesity as per BMI is 16.17% in boys and 12.07% in girls. At WHtR cut off of 0.5, a significant proportion i.e. 18.72% of boys and 24.9% of girls were found to be obese. At WHtR cut off 0.48, a more significant proportion i.e. 31.06% of boys and 39.24% of girls were found to be obese [Table-I, Figure 1, 2&3]. A higher prevalence of Obesity as per WHtR when compared with BMI in both genders, more so in girls may be due to a relatively higher waist circumference for height in south Indian children. Another observation from the study was a statistically significant difference between the BMI of private and government sector children. Also a statistically significant difference was observed between the WHtR of private and government sector children. This difference could be responsible for a higher prevalence of Undernutrition in children of government sector and a higher prevalence of Obesity in children of private sector [Table-V].

Among the variables considered i.e. age, gender, birth order, family size, type of meals, snacks, chicken intake, TV viewing and playing outdoor games, only some were found to statistically significantly influence the BMI and WHtR cut off of 0.48 whereas almost all variables were found

to significantly influence the WHtR cut off of 0.5 [Table–III]. This is not surprising, as all these factors are well known to have a bearing on a child's nutritional status. The tendency towards obesity associated with the intake of chicken may be attributed to the steroid content of broiler chicken. Moreover, TV viewing is inversely proportional to the duration of outdoor games and is associated with excessive snacking^[11].

Table I: Table showing the Prevalence of Obesity as per BMI and WHtR

S.No	Schools	Gender	Age Group (yrs)	Body Mass Index (BMI) > 95% oile	Waist to Height Ratio (WHtR)	
					≥ 0.48	≥ 0.5
1	Private n=250	Boys n=140	5 to7 n=70	14 (20%)	25 (35.7%)	17 (24.3%)
			8 to 10 n=70	18 (25.7%)	24 (34.3%)	15 (21.4%)
			Girls n=110	5 to 7 n=57	11 (19.3%)	36 (63.1%)
		8 to 10 n=53	8 (15.1%)	21 (39.6%)	15 (28.3%)	
		Boys n=95	5 to7 n=47	5 (10.6%)	15 (31.9%)	9 (19.1%)
			8 to 10 n=48	1 (2.1%)	9 (18.7%)	3 (6.2%)
Girls n=155	5 to7 n=94		4 (4.2%)	26 (27.6%)	17 (18.1%)	
8 to 10 n=61	9 (14.7%)	21 (34.4%)	12 (19.7%)			
Total	n=500			70 (14%)	177 (35.4%)	110 (22%)

Table II: Table showing Correlation between BMI and WHtR in Private school students

Correlation(Private School)			Body Mass Index	Waist to Height Ratio
Body Mass Index	Pearson Correlation	1	.720**	
	Sig. (2-tailed)		.000	
	N	250	250	
Waist to Height Ratio	Pearson Correlation	.720**	1	
	Sig. (2-tailed)	.000		
	N	250	250	

Table III: Table showing Correlation between BMI and WHtR in Government school students

Correlation (Government School)			Body Mass Index	Waist to Height Ratio
Body Mass Index	Pearson Correlation	1	.507**	
	Sig. (2-tailed)		.000	
	N	250	250	
Waist to Height Ratio	Pearson Correlation	.507**	1	

Sig. (2-tailed)	.000
N	250

Table IV: Table showing the Impact of Individual Variables on BMI and WHtR

S.No	variables	p – Value (BMI)		p – Value (WHtR)		Cut Off 0.5	
		Private	Govt. & Govt. AIDED	Private	Govt. & Govt. AIDED	Private	Govt. & Govt. AIDED
1	Age	0.965	0.000*	0.431	0.000*	0.730	0.000*
2	Gender	0.299	0.098	0.007*	0.059	0.013*	0.208
3	Birth order	0.998	0.049*	0.120	0.363	0.183	0.151
4	Family size	0.844	0.727	0.792	0.088	0.620	0.002*
5	Breakfast	0.988	0.000*	0.636	0.137	0.136	0.006*
6	Lunch	0.476	0.035*	0.328	0.112	0.193	0.004*
7	Dinner	0.671	0.217	0.592	0.057	0.198	0.005*
8	Snacks	0.947	0.079	0.710	0.216	0.358	0.026*
9	Non-veg / month	0.155	0.826	0.309	0.001*	0.274	0.010*
10	TV viewing / day	0.347	0.699	0.202	0.062	0.062	0.013*
11	Playing outdoor games / day	0.477	0.415	0.309	0.020*	0.130	0.032*

*Statistical significance, level of significance was set at 0.05

Table V: Table showing the Prevalence of Under nutrition and Obesity in Private and Government sectors

S.No			Private Schools n=250	Government & Government Aided Schools n=250	Total
1	Under nutrition	BMI <5%ile	45 (18%)	76 (30.4%)	121 24.2%)
2	Obesity	BMI >95%ile	51 (20.4%)	19 (7.6%)	70 (14%)
		WHtR – Cutoff 0.48	106 (42.2%)	71 (28.4%)	177 (35.4%)
		WHtR - Cutoff 0.5	69 (27.6%)	41 (16.4%)	110(22%)

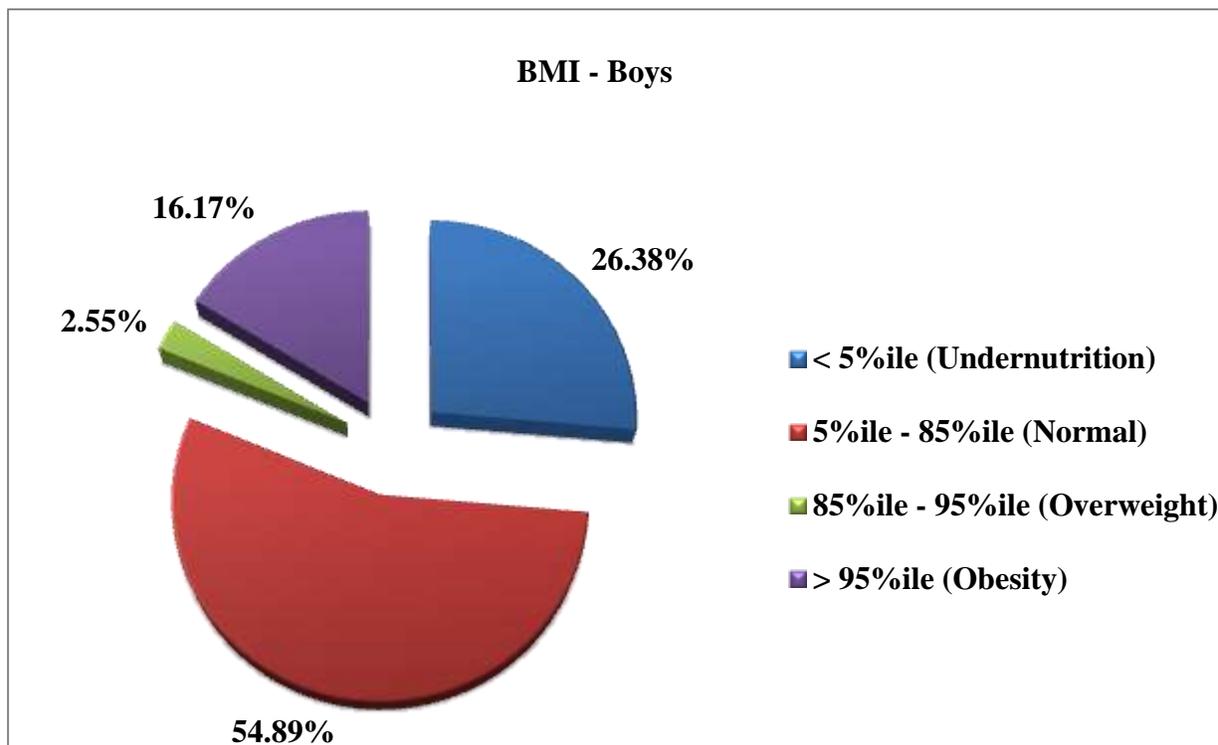


Figure 1: Figure showing Nutritional status as per BMI in boys

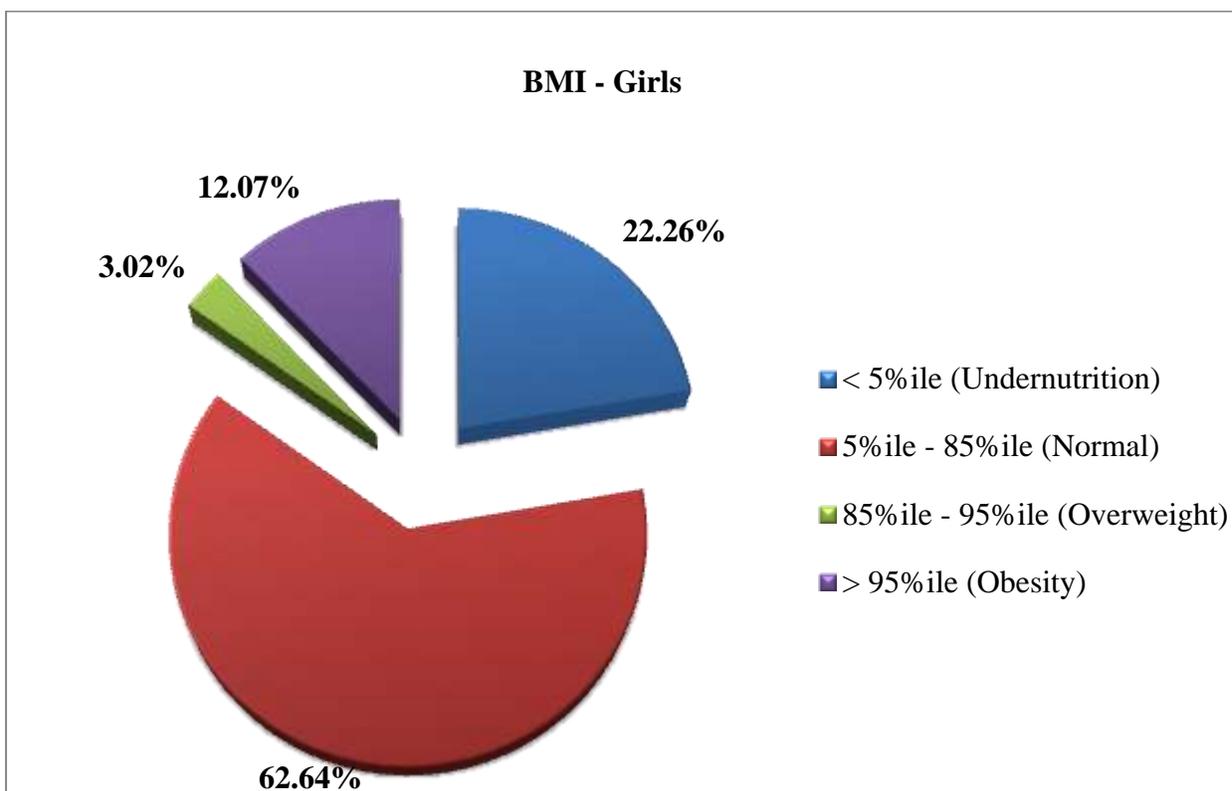


Figure 2: Figure showing Nutritional status as per BMI in girls

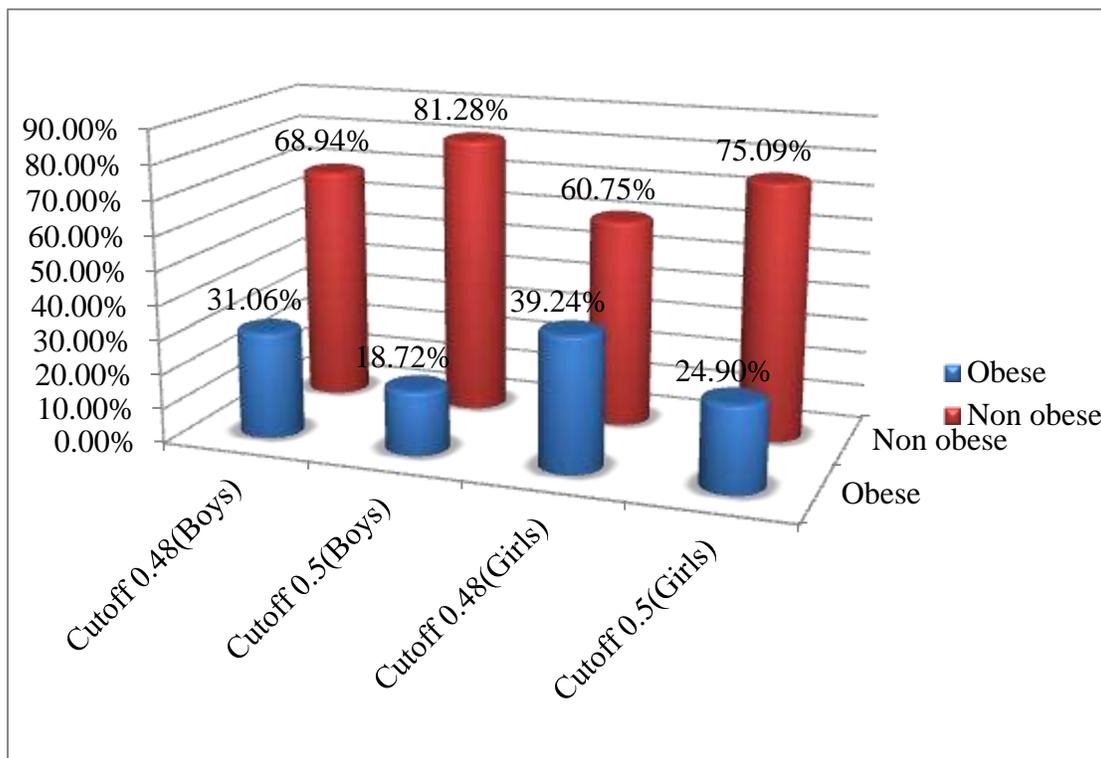


Figure 3: Figure showing Nutritional status as per WHtR in boys and girls

CONCLUSION

On validating against BMI, WHtR at 0.48 cut off is more sensitive and WHtR at 0.5 cut off is more specific for Obesity in South Indian children. However, it is prudent to apply a more sensitive cut off of WHtR i.e.0.48 to plan nutritional intervention and life style modification in all children who are truly obese (true positive). Variables namely age, birth order, breakfast and lunch are found to play a statistically significant role in the determination of BMI whereas most of the variables considered are found to play a statistically significant role in the determination of WHtR at cut off of 0.5.

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