

Prevalence of obesity among 2- 5 years old children of Amritsar: A comparison of three criteria

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ABSTRACT

This was a cross-sectional study of 1879 subjects (949 boys and 930 girls) to define the prevalence of overweight and obesity using three reference standards. The study involved affluent preschool children (2-5 years of age) from six crèches, fifteen play-pen and three public schools of Amritsar city. Weight and height was obtained for each child and body mass index was calculated according to the formula weight (kg)/ height (m)². The prevalence of overweight and obesity was then determined using Centers for Disease Control and Prevention (CDC), International Obesity Task Force (IOTF) and World Health Organization (WHO) standards. All three methods gave different results. The present study revealed that WHO standards gave higher estimates of overweight and obesity while IOTF gave lower estimates. The level of agreement ($k=0.94$) between the WHO and CDC standards was higher. The prevalence of childhood obesity is dependent on the growth reference used.

Key words: Obesity, BMI, Height, Weight, Children, Amritsar

INTRODUCTION

Being overweight and obese are the most common nutritional problems found in the pediatric populations in countries with large numbers of families belonging to upper and middle socioeconomic status (SES). BMI which is a measure of body mass relative to height, has emerged as the most practical, universally applicable, inexpensive and non-invasive anthropometric indicator for classifying overweight and obesity. Now these days various cut-off points for BMI have been established and this has enabled the differentiation of overweight and obesity into various age categories. The choice of appropriate standards is very crucial for getting comparable and reliable information on nutritional status. Flegal *et al.* (2002) reported that for younger children the use of BMI-for-age rather than weight-for-stature appears more accurate for the evaluation of nutritional status.

The majority of the studies which have tried to define the weight status of the pediatric population have analyzed school going children and adolescents with little attention being given to the evaluation of the nutritional status of pre-school children. As there are no reference standards set specifically for Indian children, so in the present study an attempt has been made to assess the prevalence of overweight and obesity among affluent pre-school Arora children (aged 2-5 years) of Amritsar using three international sets of criteria of BMI, i.e. Centers for Disease Control and Prevention/CDC (2000); International Obesity Task Force/IOTF (2000); World Health Organization/WHO (2006).

MATERIALS AND METHODS

Data were collected from 1879 (boys- 949 and girls- 930) affluent pre-school Arora children ranging in age from 2 to 5 years, for the present cross-sectional study. Guru Nanak Dev University Ethics Committee approved this study. Weight and height measurements were taken from each subjects using standard protocol of Weiner and Lourie (1981). From weight and height, body mass index (BMI) was calculated to classify the children as overweight and obese using age and gender-specific cut-points recommended by three growth references: (a.) the revised growth charts from the Centers for Disease Control and Prevention (CDC) devised by Kuczmarski *et al.*, (2000). According to this criterion, the children were classified into two categories as, “at risk of overweight” (BMI $\geq 85^{\text{th}}$ percentile and $< 95^{\text{th}}$ percentile) and “overweight” ($\geq 95^{\text{th}}$ percentile). (b) the International Obesity Task Force (IOTF) devised by Cole *et al.* (2000). According to this classification (i) if BMI analogue for age and sex is 25 kg/m² and more but less than 30 kg/m², then the child is overweight and (ii) if BMI analogue for age and sex is 30 kg/m² and more, then the child is obese. (c) the World Health Organization standards devised by de Onis *et al.* (2006). According to this criterion, ‘possible risk of overweight’ was defined as BMI greater than +1 standard deviation (SD), but less than or equal to +2SD and ‘overweight’ was defined as BMI greater than +2SD. Statistical comparison was conducted using Chi-square analysis for categorical data. Cohen’s kappa statistic was calculated to determine the level of agreement between the growth references. A kappa greater than .80 signifies very good agreement, between .60-.80 a good level of agreement and that less than .50 little to moderate agreement (Cohen, 1960). Level of significance was set at $p < 0.05$. All the data was analyzed using the Statistical Package for the Social Sciences (SPSS 16.0).

RESULTS

It is evident from the Table 1 that according to CDC criterion, the percentage prevalence of overweight, obesity and combined overweight/obesity in the sampled Arora pre-school children (pooled sample) was

10.3%, 3.3% and 13.6%, respectively. It is evident from Table 1 that according to CDC criterion, the prevalence of overweight was 11.7% among boys and 8.8% among girls, while the prevalence of obesity

Table 1 Percentage prevalence of Overweight (Ow), Obesity (Ob) and Combined Overweight/Obesity (Ow/Ob) using CDC (2000), IOTF (2000) and WHO (2006) cut-points among preschool children

Nutritional status	Reference cut-points	Percentage prevalence									
		Age Group (years)								Total Sample (1879)	
		2+ (402)		3+ (473)		4+ (494)		5+ (510)			
		Boys (204)	Girls (198)	Boys (220)	Girls (253)	Boys (254)	Girls (240)	Boys (271)	Girls (239)	Boys (949)	Girls (930)
Ow	CDC	6.9 (14)	4.0 (8)	6.8 (15)	9.9 (25)	13.0 (33)	10.4 (25)	18.1 (49)	10.0 (24)	11.7 (111)	8.8 (82)
	IOTF	3.4 (7)	4.0 (8)	5.0 (11)	5.1 (13)	6.3 (16)	7.9 (19)	10.3 (28)	7.1 (17)	6.5 (62)	6.1 (57)
	WHO	7.8 (16)	4.0 (8)	6.8 (15)	6.7 (17)	15.0 (38)	10.0 (24)	18.1 (49)	8.4 (20)	12.4 (118)	7.4 (69)
Ob	CDC	2.4 (5)	2.0 (4)	2.3 (5)	2.0 (5)	5.1 (13)	4.2 (10)	3.7 (10)	4.2 (10)	3.5 (33)	3.1 (29)
	IOTF	2.4 (5)	0.5 (1)	0.9 (2)	3.2 (8)	2.0 (5)	1.7 (4)	2.2 (6)	2.9 (7)	1.9 (18)	2.1 (20)
	WHO	3.9 (8)	4.0 (8)	4.1 (9)	3.2 (8)	7.1 (18)	5.0 (12)	5.9 (16)	5.9 (14)	5.4 (51)	4.5 (42)
Combined Ow/Ob	CDC	9.3 (19)	6.1 (12)	9.1 (20)	11.8 (30)	18.1 (46)	14.6 (35)	21.8 (59)	14.2 (34)	15.2 (144)	11.9 (111)
	IOTF	5.9 (12)	4.5 (9)	5.9 (13)	8.3 (21)	8.3 (21)	9.6 (23)	12.5 (34)	10.0 (24)	8.4 (80)	8.3 (77)
	WHO	11.8 (24)	8.1 (16)	10.9 (24)	9.9 (25)	23.3 (56)	15.0 (36)	24.0 (65)	14.2 (34)	17.8 (169)	11.9 (111)

was 3.5% among boys and 3.1% among girls, respectively. The combined percentage prevalence of overweight and obesity was comparatively more among boys (15.2%) than girls (11.9%). In the total sample (age group 2+ to 5+) out of 1879 children 6.3% (119) were overweight and 2.0% (38) were obese (Table 1) using the IOTF (2000) criterion. Thus the combined percentage prevalence of overweight and obesity in the present sample was observed as 8.3% (Boys: 8.4%; Girls: 8.3%). Table 1 also shows that based on WHO criterion, the overall combined percentage prevalence of overweight and obesity among studied

Table 2 Comparison of percentage prevalence of Overweight (Ow), Obesity (Ob) and Combined Overweight/Obesity (Ow/Ob) and level of agreement (kappa statistic) using CDC (2000), IOTF (2000), and WHO (2006) cut-points

Nutritional status	Reference cut-points	Percentage prevalence		
		Total	Boys	Girls
Ow	CDC	10.3	11.7	8.8
	IOTF	6.3	6.5	6.1
	WHO	9.9	12.4	7.4
	WHO minus CDC	-	0.7	-
	WHO minus IOTF	3.6	5.9	1.3
	CDC minus IOTF	4.0	5.2	2.7
Ob	CDC	3.3	3.5	3.1
	IOTF	2.0	1.9	2.1
	WHO	4.9	5.4	4.5
	WHO minus CDC	1.6	1.9	1.4
	WHO minus IOTF	2.9	3.5	2.4
	CDC minus IOTF	1.3	1.6	1.0
Combined Ow/Ob	CDC	13.6	15.2	11.9
	IOTF	8.3	8.4	8.3
	WHO	14.9	17.8	11.9
	WHO minus CDC	1.3	2.6	-
	WHO minus IOTF	6.6	9.4	3.6
	CDC minus IOTF	5.3	6.8	3.6

Kappa statistic considering three reference standards separately: WHO-CDC-0.94, WHO-IOTF-0.54, CDC-IOTF-0.44

pre-school children of Amritsar was 14.9% (Boys: 17.8% and Girls: 11.9%). The percentage prevalence of overweight in the pooled sample was almost double (9.9%) than the percentage prevalence of obesity (4.9%). It was apparent from the present study (Table 2) that the prevalence of overweight was 4.0 percentage points higher according to CDC (2000) than the IOTF (2000) criteria. On the other hand, in case of obesity the prevalence was 1.3 percentage points higher according to CDC (2000) than the IOTF (2000) cut-points. The prevalence of combined overweight/obesity, on the contrary, was 5.3 percentage points higher according to

CDC (2000) than the IOTF (2000) criteria. In the pooled sample, WHO (2006) and CDC (2000) gave the similar prevalence of overweight, on the other hand, prevalence of obesity was only 1.6 percentage points more according to WHO (2006) than CDC (2000) criteria. In case of combined overweight/obesity, the WHO (2006) criterion gave 1.3 percentage points higher than CDC (2000) criterion. This reveals that the WHO (2006) cut-points were almost closer to those of the CDC (2000) cut-points. Similarly in the present study an attempt has also been made to compare the criteria of WHO (2006) and IOTF (2000) and observed that the prevalence of overweight was 3.6 percentage points higher according to WHO (2006) than the IOTF (2000) criteria (Table 2). On the other hand, the prevalence of obesity was 2.9 percentage points greater according to

Table 3 Comparison of percentage prevalence of Overweight and Obesity, by sex, among pre-school children (2-5 years old) of various countries using CDC (2000), IOTF (2000) and WHO (2006) cut-points

Country	Percentage of Overweight									Percentage of Obesity									References
	CDC (2000)			IOTF (2000)			WHO (2006)			CDC (2000)			IOTF (2000)			WHO (2006)			
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	
Bahrain	-	-	-	7.2	6.2	-	9.8	10.1	-	-	-	-	3.0	4.2	-	7.1	5.9	-	Al-Raees <i>et al.</i> (2009)
Canada	23.8	31.2	27.5	28.2	35.0	31.6	-	-	-	40.5	34.2	37.4	20.9	21.6	21.3	-	-	-	Willows <i>et al.</i> (2007)
Canada	-	-	11.3	-	-	9.1	-	-	14.4	-	-	12.0	-	-	7.1	-	-	9.2	Gardner <i>et al.</i> (2010)
Canada	-	-	-	-	-	-	-	-	-	15.0	12.4	13.7	6.3	6.4	6.3	11.8	9.4	10.6	Shields and Tremblay (2010)
Canada	-	-	19.1	-	-	18.2	-	-	26.7	-	-	16.6	-	-	8.3	-	-	11.3	Twells and Newhook (2011)
China	7.3	8.8	8.0	6.7	8.5	7.6	4.6	2.7	3.7	8.1	5.5	6.8	3.9	3.1	3.5	2.9	1.7	2.3	Shan <i>et al.</i> (2010)
Greek	16.3	16.2	-	12.9	15.5	-	-	-	-	16.0	15.5	-	6.2	8.1	-	-	-	-	Manios <i>et al.</i> (2007)
Italy	16.1	15.7	-	12.9	15.7	-	-	-	-	10.5	11.9	-	0.8	6.7	-	-	-	-	Vidal <i>et al.</i> (2006)
Saudi Arabia	12.7	12.8	12.8	-	-	-	15.9	15.4	15.7	6.2	5.3	5.8	-	-	-	5.4	4.6	5.0	El Mouzan <i>et al.</i> (2010)
India	11.7	8.8	10.3	6.5	6.1	6.3	12.4	7.4	9.9	3.5	3.1	3.3	1.9	2.1	2.0	5.4	4.5	4.9	Present study

WHO (2006) than the IOTF (2000) cut-points. In case of combined overweight/obesity, the prevalence was 6.6 percentage points higher according to WHO (2006) than the IOTF (2000) criteria. Thereby it reveals that the differences in the percentage prevalence of overweight, obesity and combined overweight/obesity were wide between the WHO (2006) and IOTF (2000) cut-points.

This proves that the estimates of the prevalence of overweight/obesity according to WHO (2006) criterion were relatively closer to the CDC (2000) criterion, while IOTF (2000) gave lower estimates than WHO (2006) criterion. This study therefore illustrates that the percentage of children classified as overweight or obese or combined overweight/obese varies considerably depending on the BMI cut-offs

DISCUSSION

In the pooled sample, according to the criterion of CDC (2000) the percentage prevalence of overweight and obesity separately among boys was 11.7% and 3.5% while among girls it was 8.8% and 3.1%, respectively (Table 1). According to IOTF (2000) criterion the percentage prevalence of overweight and obesity among boys was 6.5% and 1.9% whereas among girls it was 6.1% and 2.1%, respectively (Table 1). The percentage prevalence of overweight according to the WHO (2006) criterion was 12.4% and 7.4% and obesity was 5.4% and 4.5% among boys and girls, respectively (Table 1). This shows that using different criteria the percentage prevalence of overweight was quite high than the percentage prevalence of obesity on the basis of implied methods. Similar to the present study, various studies (Vidal *et al.*, 2006; Manios *et al.*, 2007; Al-Raees *et al.*, 2009; El Mouzan *et al.*, 2010; Shan *et al.*, 2010; Shields and Tremblay, 2010) reported that proportion of overweight was higher than the obesity using different criteria for the assessment of overweight and obesity. On the other hand, Willows *et al.* (2007) assessed the prevalence of overweight and obesity among Canadian pre-school children using CDC (2000) and IOTF (2000) criteria and found that the proportion of obesity was more than overweight with CDC (2000) criterion.

Table 1 also illustrates that the percentage of children classified as overweight/obese varies considerably, depending on the BMI cut-points used. The WHO (2006) cut-points yield the highest estimates and IOTF (2000) cut-points, the lowest while CDC (2000) cut-points in between the two. Similar results (Table 3) were reported by three studies (Gardner *et al.*, 2010; Shan *et al.*, 2010; Twells and Newhook, 2011) among Canadian pre-school children. However, in contrast to the present study, Shan *et al.* (2010) studied Chinese children and reported that CDC (2000) criterion gave higher estimates for the prevalence of overweight and obesity than the IOTF (2000) criterion and the WHO (2006) cut-offs gave the lowest estimates and the prevalence of overweight using IOTF (2000), WHO (2006) and CDC (2000) cut-points was 7.6%, 3.7% and 8.0%, respectively, while the prevalence of obesity was 3.5%, 2.3% and 6.8% using the above mentioned criteria.

Present study (Table 2) depicts that the prevalence of overweight, obesity and combined overweight/obesity in the Arora children was higher according to the CDC (2000) criterion than the IOTF (2000) criterion. The association between these two criteria was further calculated using Chi-square analysis (Figs 1-3) and from this analysis it is evident that the differences in the prevalence of overweight (boys: $\chi^2=13.31$; $p<0.05$ and girls: $\chi^2=4.14$; $p<0.05$) and combined overweight/obesity (boys: $\chi^2=17.71$; $p<0.05$ and girls: $\chi^2=5.79$; $p<0.05$) estimated by these two criteria were statistically significant in boys and girls while insignificant in case of obesity among both sexes. Using kappa statistic, the level of agreement between CDC and IOTF was 0.44. Several previous studies also reported that CDC (2000) criterion gave higher estimates of overweight and obesity than the IOTF (2000) criterion. Willows *et al.* (2007) studied the prevalence estimates of overweight and obesity in Cree pre-school children in Northern Quebec according to IOTF (2000) and CDC (2000) criteria, and reported that CDC (2000) reference (overweight: 27.5% and obese: 37.4%) provided higher frequency of obesity compared with the IOTF (2000) reference (overweight: 31.6% and obese: 21.3%) although differences in the prevalence of overweight were smaller in magnitude. Manios *et al.* (2007) studied pre-school Greek children and compared both CDC (2000) and IOTF (2000) methods for the assessment of overweight and obesity. They found that the prevalence of being at risk of overweight and overweight was 16.3% and 16.0% in boys and 16.2% and 15.5% in girls, respectively by the CDC (2000) method. The prevalence of overweight and obesity was 12.9% and 6.2% in boys and 15.5% and 8.1% in girls, respectively by the IOTF (2000) method. The proportion of children categorized as overweight using the CDC (2000) method was significantly higher both for boys and girls than IOTF (2000) method. Vidal *et al.* (2006) observed the prevalence of overweight/obesity among Italian children using the age-related BMI percentiles of the CDC (2000), IOTF (2000) and BMI charts developed by Luciano *et al.* (2003) and found that the CDC (2000) method demonstrated a significantly higher rate of overweight than the standards of IOTF (2000) and Luciano *et al.* (2003) whereas the latter two did not show any significant difference when compared with each other. Flegal *et al.* (2001) studied the prevalence of overweight in US children according to three sets of reference BMI values: the revised growth charts of the Centers of Disease Control and Prevention (CDC, 2000) –US growth charts, international proposed by Cole *et al.* (2000) and values developed by Must *et al.* (1991) and reported that three methods gave similar but not identical results. The reference values of Cole *et al.* (2000) gave lower estimates than did the CDC-US (2000) growth charts for young children but higher estimates in older children. Twells and Newhook

(2011) studied Canadian pre-school children and found that CDC criterion (Overweight: 19.1% and Obesity: 16.6%) gave higher estimates of overweight and obesity than IOTF criterion (Overweight: 18.2% and Obesity: 8.3%) respectively (Table 3).

Chi-square analysis revealed that the differences in prevalence of overweight, obesity and combined overweight/obesity estimated by WHO and CDC criteria among both boys and girls were statistically insignificant (Figs. 1-3). Level of agreement between these criteria was 0.94. Similar results have also been reported by previous reports. El Mouzan *et al.* (2010) compared the criteria of WHO (2006) and CDC (2000) among pre-school children of Saudi Arabia and reported that the prevalence of BMI > +2SDS (Overweight, according to the WHO cut-off) in the age group 24-60 months was 5.0% and 5.8% based on the WHO (2006) and CDC (2000) criteria, respectively. Prevalence values using a lower cut-off for BMI for age > +1SDS (equivalent to CDC cut-off for Overweight) were 15.7% and 12.2% based on the WHO (2006) and CDC (2000) references, respectively. Thereby it shows that CDC (2000) criterion for the overweight based on > +2SDS was closer to those of the WHO (2006) criterion. Norris *et al.* (2009) studied the prevalence of overweight among South African pre-school children (0-5 years) using the criteria of NCHS (1977), CDC (2000) and WHO (2006) and observed that the prevalence of overweight was 6.1%, 6.6% and 12.0% at the age of 24 months according to these criteria, while, using the above criteria, the prevalence of overweight was 3.5%, 0.9% and 1.3% at the age of 60 months. This depicts that CDC (2000) and WHO (2006) estimates were approximately closer in case of overweight at the age of 60 months (Table 3).

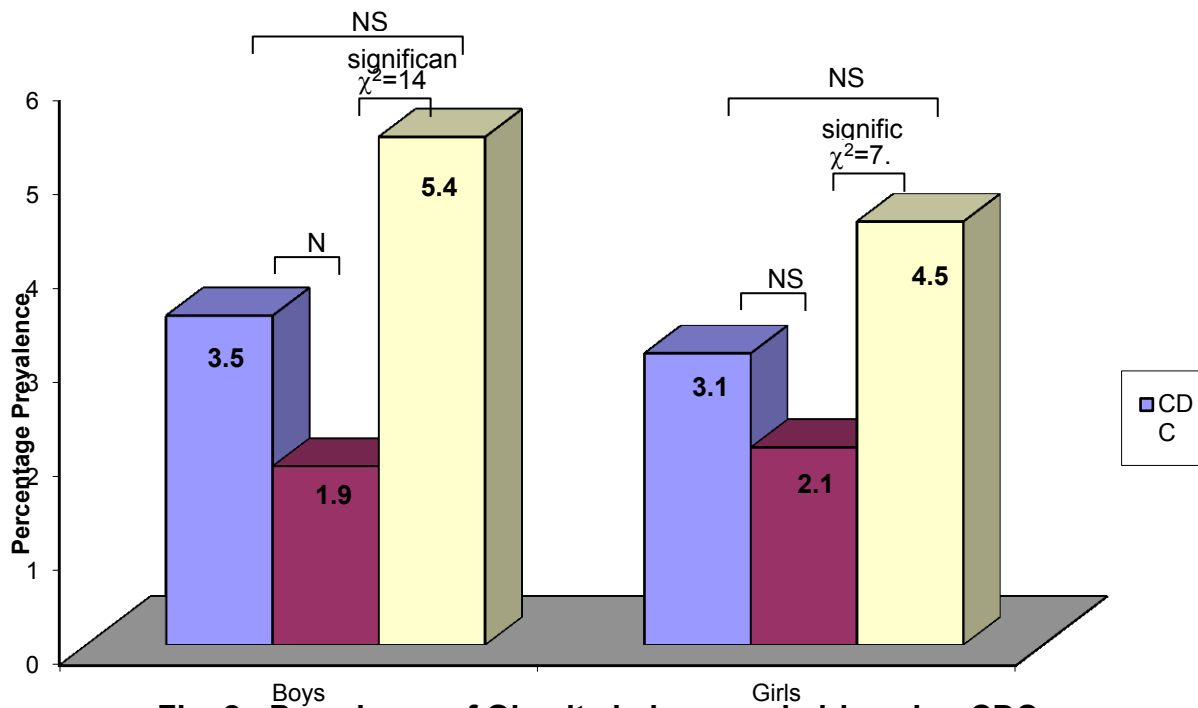
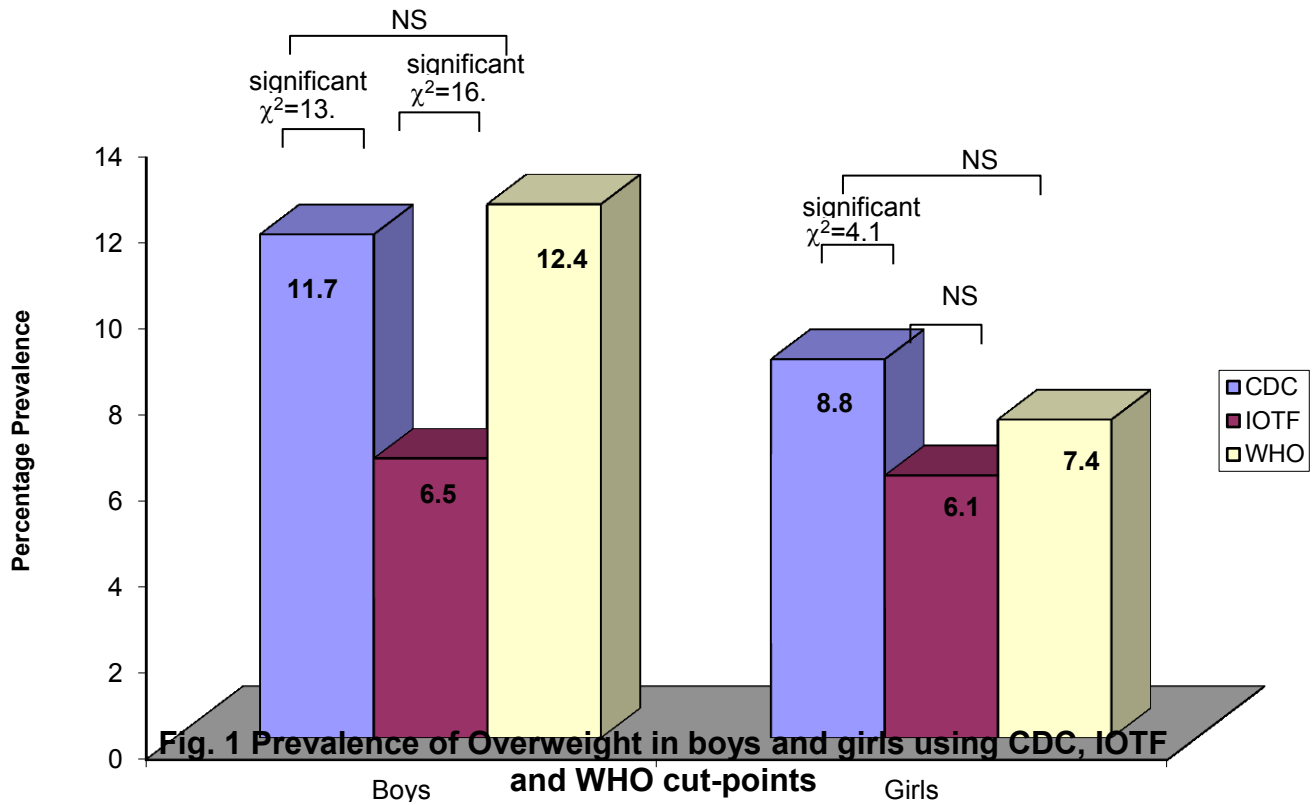
Fig. 1-3 depicts that the differences in the prevalence of overweight estimated by WHO and IOTF criteria were statistically significant in boys ($\chi^2=16.80$; $p<0.05$) while insignificant in case of girls. On the other hand, the differences in the prevalence of obesity (boys: $\chi^2=14.84$; $p<0.05$ and girls: $\chi^2=7.11$; $p<0.05$) and combined overweight/obesity (boys: $\chi^2=31.10$; $p<0.05$ and girls: $\chi^2=5.79$; $p<0.05$) were significant among both sexes. Present results also depicts that k-value between above mentioned criteria was 0.54. The results of the present study are in agreement with the findings of Al-Raees *et al.* (2009) carried out on Bahraini children (ranging in age from two-five years). They observed that the prevalence of overweight and obesity was 7.2% and 3.0% among boys and 6.2% and 4.2% among girls according to the IOTF (2000) criterion, whereas, based on WHO (2006) standards, the prevalence of overweight and obesity was 9.8% and 7.1% among boys and 10.1% and

5.9% among girls, respectively. This shows that relative to the IOTF (2000) indicators, WHO (2006) cut-offs gave higher estimates of both overweight and obesity (Table 3). Thus the present study illustrates that the percentage prevalence of children classified as overweight and obese varies considerably depending on the BMI cut-points used. Future research should be cognizant of the different growth references that can be used to define obesity among children in India including their strengths and weaknesses. Regardless of the growth reference used, it is clear that overweight and obesity in pre-school children is a great problem and accurate understanding of which this emerging epidemic affects children is critical to subsequent studies that are designed to understand the reason for the same. These studies, in turn, must then be used to derive the development of effective intervention, which is urgently required in India.

Although the association between increasing BMI and increased health risk has been substantiated in adults (WHO, 1998), it is important to raise a concern that none of these methods have been convincingly linked to the future development of adverse health outcomes in children. Researchers should also be aware of the differences between these three standards. No single method is necessarily the correct method. Each method has its advantages and limitations and each should be used cautiously, with awareness of its possible limitations.

CONCLUSIONS

To assess the nutritional status, prevalence of overweight/obesity was calculated using the BMI criteria of Centers for Disease Control and Prevention (CDC), International Obesity Task Force (IOTF) and World Health Organization (WHO) among pre-school children of Amritsar. It has been observed that according to CDC criterion, the prevalence of overweight and obesity was 11.7% and 3.5% among boys and 8.8% and 3.1% among girls. According to the criterion of IOTF, 6.5% of boys and 6.1% of girls were overweight while the prevalence of obesity has been observed as 1.9% and 2.1%, respectively among boys and girls. On the basis of WHO criterion, 12.4% of boys and 7.4% of girls were overweight and 5.4% and 4.5% of boys and girls were obese, respectively. Therefore it has been observed in the present study that prevalence of overweight and obesity varies according to the criteria used. The WHO criterion gave the higher estimates of overweight and obesity while IOTF criterion gave the lower estimates. Thus the prevalence of overweight and obesity is dependent on the growth reference used.



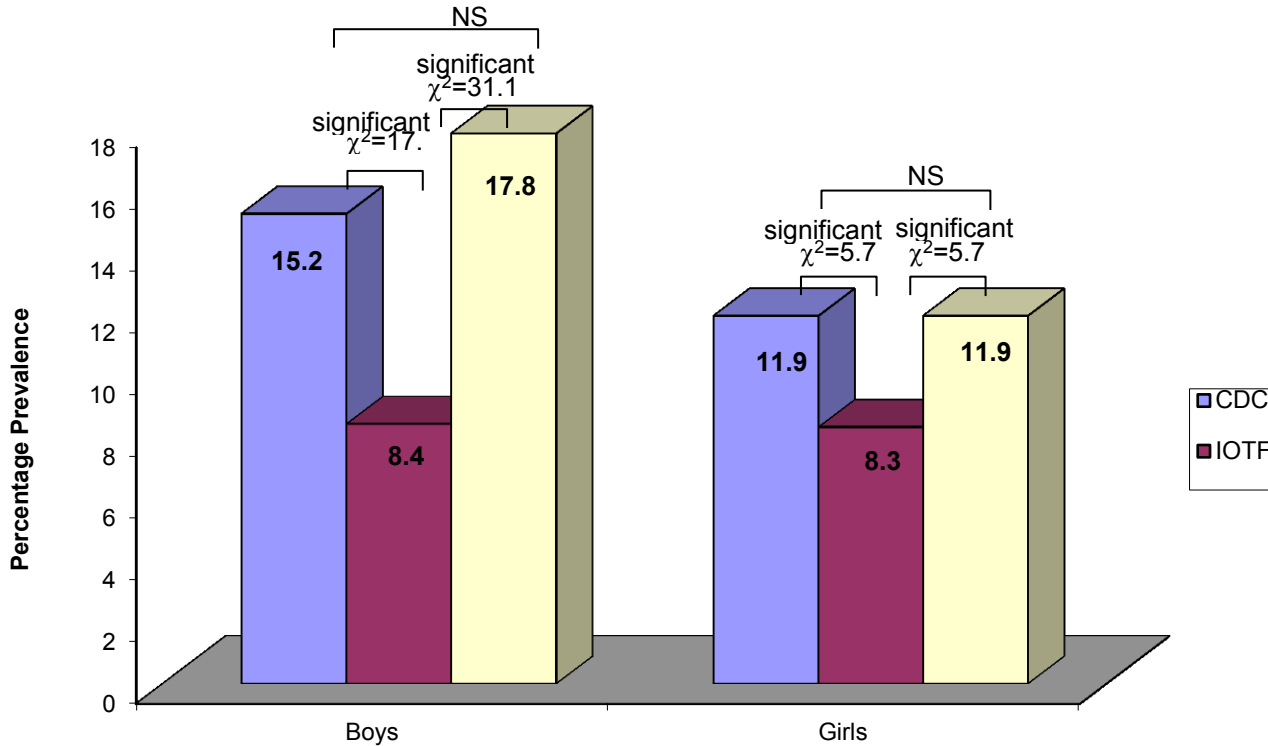


Fig. 3 : Prevalence of Combined Overweight/Obesity using CDC, IOTF and WHO cut-points

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