



Neck Circumference measurement As a screening tool For Overweight and Obesity In Children

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ABSTRACT

To investigate the relationship between neck circumference (NC) and other markers of obesity like body mass index (BMI), waist/hip ratio (WHR) and to find a cut off neck circumference value to identify children with a high BMI. Cross sectional observational study done in 413 children aged between 7 to 16 years. Anthropometric markers of obesity including body mass index (BMI), waist circumference (WC), hip circumference (HP), waist-to-hip ratio (WHR) were measured and compared with neck circumference of the same subjects. All anthropometric measures were found significantly higher in over weight/obese children when compared with their normal weight peers. Neck circumference had a strong positive correlation with other anthropometric measures like BMI, waist/hip ratio in both boys and girls with a p value of <0.001. Best cut-off value of neck circumference by ROC to identify boys with high BMI is 30 cm with a sensitivity of 97.6% and specificity of 79.9%. The same for girls was 30.2 cm with 97% sensitivity and 80% specificity. Neck circumference significantly correlated with other indices of obesity and hence can be used with great reliability to screen overweight and obesity in children.

Keywords: Neck circumference, Obesity, Waist to height ratio, BMI.

Received 21.02.2022

Revised 18.03.2022

Accepted 30.03.2022

INTRODUCTION

The existence of obesity around the globe has guided to be avail oneself as 'GLOBESITY' to narrate the epidemic drift towards increased body weight[1]. Over weight and obesity results in the risk of type 2 diabetic mellitus, hypertension and cardiovascular diseases in later life[2].

The most popular tool for assessing overweight and obesity is body mass index (BMI) a ratio of weight by the square of height. Based on the US Center for Disease Control (CDC) percentiles, childhood overweight and obesity are considered those in the 85-94 and > 95 percentiles, respectively [3]. Other anthropometric measures like WC, WHR are also used in estimating central obesity.

BMI will not show distribution of body fat whereas measurement of waist circumference shows central obesity which is time consuming and may vary by abdominal distension after having food or bowel dysfunction. Sagittal abdominal circumference and skin fold thickness like triceps/subscapular are indicators of subcutaneous adiposity. But those measurements may not be possible to bring out during a hectic day to day practice. And other investigations like DEXA [dual energy x ray absorptiometry], USG, CT, and MRI are expensive. In primary care practices there is a need for quick and well founded method for appraising obesity. Comparatively the release of free fatty acids are larger from upper body subcutaneous fat than that of lower body fat[4], a fat that strengthens the importance of upper body subcutaneous adipose tissue depot. Neck circumference measurements were pointed as an index of upper body fat scattering and can be used as a structural and uncomplicated screening measure to indicate over weight/obesity. The aim of this study is to determine whether neck circumference alone can be used to identify overweight and obese children. The objective is to find the correlation between neck

circumference and other markers of obesity like body mass index (BMI), waist/hip ratio (WHR) in evaluating obesity and also to find a cut off neck circumference to identify children with high BMI.

MATERIAL AND METHODS

Cross-sectional observational study done in Vinayaka Mission's KirupanandhaVariyar Medical College & Hospital, Salem for 12 months from october 2019 to october 2020. Children attending paediatricopd were enrolled in the study.

Inclusion criteria: Children aged between 7 to 16 years.

Exclusion criteria: Thyroid swelling such as goiter, Abnormalities of cervical spine, Cervical lymphadenopathy, Children with procedures like tracheostomy or use of cervical collar, Children with cushing syndrome and medication like steroids etc.

Method of Data Collection: Anthropometric markers of obesity measured are body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-to-hip ratio (WHR) and compared with neck circumference of the same subjects. Height was measured using a stadiometer, child standing with barefoot and head held in Frankfurt horizontal plane to the nearest 0.1 cm. Weight was measured by using a calibrated electronic weighing scale, to the nearest 0.1 kg. BMI was calculated by dividing weight in kilograms (kg) by the square of their height in meters (kg/m^2). WC was measured by using flexible measuring tape to the nearest 0.1 cm with the child standing, and at the end of normal expiration at a point midway between the inferior margin of the lowest rib and the iliac crest. Hip circumference (HC) was measured at the maximum circumference around the buttocks.

WHR was calculated by dividing WC by HC. Neck circumference was measured by using a flexible tape, with the child in the standing position, head held erect and eyes facing forward and the neck in a horizontal plane at the level of most prominent portion, the thyroid cartilage.

After calculation, BMI is plotted on the Revised IAP 2015 Growth Charts for BMI (for either girls or boys) to obtain a percentile ranking. Children were classified into normal, overweight and obese based on BMI cut off lines as per the Revised IAP 2015 Growth Chart :-

- Below 23rd AE (Adult Equivalent): No overweight/No obese (between 5th to 84th percentile).
- Between 23rd to below 27th AE (Adult Equivalent) : Overweight (between 85th to 94th percentile).
- 27th AE (Adult Equivalent) and above: Obese (above 95th percentile).

Statistical analysis: SPSS version 21 software was used for calculations and the results were considered statistically significant with $P \leq 0.05$. Categorical and continuous measurements were computed as presented in number (%) and Mean \pm SD respectively. To study the significance of parameters on a continuous scale between two groups, two tailed student t-test was used. To study the association between various anthropometric measurements, Pearson correlation for was used to find the degree of relationship. The ROC (receiver operating characteristic) curves analyzed the cutoff values of neck circumference to identify overweight and obesity.

RESULTS

Our study enrolled 413 children out of which 206 were girls and 207 were boys. Mean BMI for girls is 17.54 ± 3.42 and for boys is 17.66 ± 3.04 . Mean NC of girls is 29.27 ± 2.39 and that of boys is 29.61 ± 2.36 . In the study population 33 (7.9%) girls and 43 (10.3%) boys were found to be overweight/obese.

TABLE 1: COMPARISON BETWEEN NECK CIRCUMFERENCE AND BMI IN OVER WEIGHT AND OBESE CHILDREN

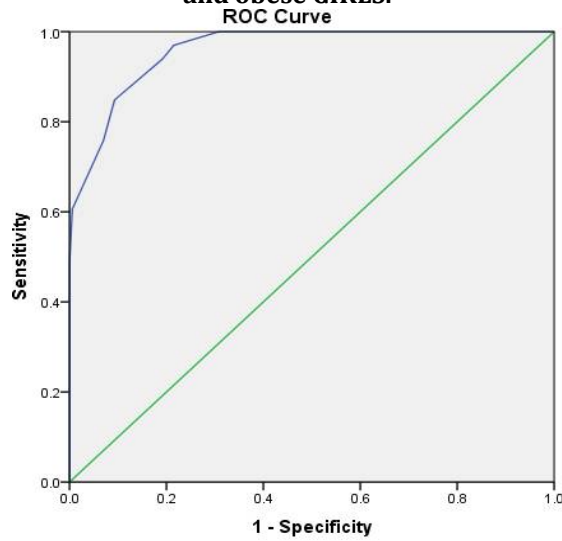
	BMI STATUS	N	MEAN NC	Std DEVIATION	P value (student t test)
girls	Normal weight	173	28.605	1.9340	0.0001
	Over weight and Obese	33	32.742	1.3700	
boys	Normal weight	164	28.795	1.8295	0.0001
	Over weight and Obese	42	32.833	1.1617	

Mean NC of overweight and obese boys is $32.83 \text{ cm} \pm 1.16 \text{ cm}$

Mean NC of overweight and obese girls is $32.74 \text{ cm} \pm 1.37 \text{ cm}$

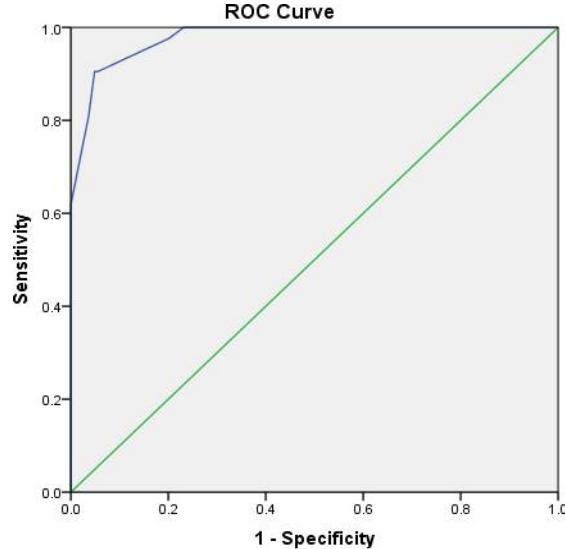
Association between Neck circumference and BMI in over weight and obese children is statistically significant $p < 0.0001$.

FIGURE 1: Receiver Operating Characteristic (ROC) curve comparing NC and BMI in over weight and obese GIRLS.



Diagonal segments are produced by ties.

FIGURE 2: Receiver Operating Characteristic (ROC) curve comparing NC and BMI in over weight and obese BOYS.



Diagonal segments are produced by ties.

TABLE 2: Asymptomatic 95% Confidence Interval

	Area under the curve	Std. Error ^a	P value	Asymptomatic 95% Confidence Interval	
				Lower bound	Upper bound
Girls	.959	.014	.0001	.932	.986
Boys	.978	.009	.0001	.961	.995

- ROC cut off value of neck circumference in overweight and obese girls is 30.2 cm with Sensitivity - 97% and Specificity - 80%.
- ROC cut off value of neck circumference in over weight and obese boys is 30 cm with Sensitivity - 97.6% and Specificity - 79.9%.

TABLE 3: PEARSON CORRELATION (R) BETWEEN NECK CIRCUMFERENCE AND OTHER ANTHROPOMETRIC PARAMETERS FOR GIRLS AND BOYS

	Correlation coefficient (P value)		
	BMI and NC	BMI and WHR	WHR and NC
Girls	0.785 (0.0001)	0.716 (0.0001)	0.734 (0.0001)
Boys	0.756 (0.0001)	0.613 (0.0001)	0.694 (0.0001)

Neck circumference showed a strong positive correlation with BMI and WHR in both girls and boys.

DISCUSSION

In children, obesity has become a considerable general health problem. Many studies have manifested about the increasing disadvantages of obesity as both long term and short term consequences [5,6]. Renata et al showed association of neck circumference and high blood pressure in children and adolescents [7]. Katz et al had shown that neck to waist ratio, an index of body fat distribution predicts obstructive sleep apnoea in overweight/obese children [8]. Managing obesity in terms of detection, treatment and early prevention has become a prime concern which needs precise diagnostic measures. Monitoring and screening accessories must be cheap, easy to handle and in general it must be affordable by both health practitioners and patients.

A study conducted by Mehri Taheri et al. Ahvaz Iran found that neck circumference significantly correlated with overweight and obesity. In that study 288 (33%) children were less than 10 years and 576 (67%) were more than 10 years. In our study 116 (28%) children were less than 10 years and 297 (72%) were more than 10 years. Vague J, who was the first person to propose that different types of fat distribution and morphology of body are related with the risk of obesity and used neck skin fold to evaluate upper body fat distribution [9]. Limitations of other methods which are used to monitor obesity in both adult and children leads the researchers to find some alternate ways for screening this condition, which include the neck circumference measurement as a new indicator for central obesity [10,11]. The studies conducted at Iran, Turkey and also USA revealed that neck circumference and waist circumference increases along with the age of the child. Hence those parameters are strongly correlated with BMI [10,11,12,13].

Studies conducted in adults have shown that neck circumference which can be used as a simple tool for screening individuals with high BMI, with good reliability. Several other studies have shown relation between neck circumference with other obesity indices [14]. But, in paediatric age group there are limited studies on measurement of neck circumference as an index of obesity.

A study conducted by Hatipoglu et al. Kayseri, Turkey suggested neck circumference can be used as an additional measure to screen children with overweight and obesity and also found a positive correlation between NC, BMI and WC. The cut-off values that showed higher sensitivity and specificity for NC to detect overweight is 28-31 cm for girls and 29-32.5 cm for boys [13]. In our study best cut-off value of neck circumference by ROC to identify boys with high BMI is 30 cm with a sensitivity of (97%) and specificity of (80%). The same for girls was 30.25 cm with 97% sensitivity and 79% specificity.

The present study had similar results with other studies. In our study the cut off value of neck circumference to identify children with high BMI is 32.83 ± 1.16 cm and 32.74 ± 1.37 cm in boys and girls respectively. NC in boys is more than girls. All anthropometric parameters found to be significantly higher in overweight/obese children with $P < 0.001$. In this study we concluded that neck circumference significantly correlated with other indices of obesity and it can be used with great reliability to screen overweight and obesity in children.

CONCLUSION

In this study we concluded that neck circumference significantly correlated with other indices of obesity and it can be used with great reliability to screen overweight and obesity in children. Hence neck circumference can be thus considered as a simple, time saving and inexpensive clinical tool for detection of overweight and obesity in a busy OPD.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

1. W P T James. (2008). WHO recognition of the global obesity epidemic. *Int J Obes* ; 32(7): 120-126.
2. Jagdish P Agrawal, Virendra K Gupta, Madhur Jain. (2017). A study of prevalence of obesity among adolescents (10-19 years) in Jaipur city with special reference to lifestyle. *Int J Contemp Pediatr*; 4(4) 1461-1465.

3. Behrman RE, Kliegman M, Stanton BF, Schor NF. (2011). Overweight and Obesity. Nelson textbook of Pediatrics ; 19:179-188.
4. M D Jensen. (1997). Lipolysis: contribution from regional fat. *Annu Rev Nutr* ; 17: 127-139.
5. Kelishadi R. Childhood overweight, obesity, and the metabolic syndrome in developing countries. *Epidemiol Rev* 2007; 29: 62-76.
6. Djalalinia S, Qorbani M, Peykari N. Health impacts of obesity. *Pak J Med Sci* 2015 Jan-Feb; 31(1): 239-242.
7. Kuciene R, Dulskiene V, Medzioniene J. Association of neck circumference and high blood pressure in children and adolescents:a case-control study. *BMC Pediatrics* 2015; 15: 127.
8. Katz S, Vaccani J, Barrowman N. Does neck to waist ratio predict obstructive sleep apnea in children. *J Clin Sleep Med* 2014 Dec; 10(12): 1303-1308.
9. Vague J. The degree of masculine differentiation of obesities: A factor determining predisposition to diabetes, atherosclerosis, gout, and uric calculous disease. *Am J Clin Nutr* 1956 Jan-Feb; 4(1): 20-34.
10. Nafiu OO, Burke C, Lee J, Voepel-Lewis T, Malviya S, Tremper KK. Neck circumference as a screening measure for identifying children with high body mass index. *Pediatrics* 2010 Aug; 126(2): e306-e310.
11. Hatipoglu N, Ozturk A, Mazicioglu MM et al. (2008). Waist circumference percentiles for 7- to 17-year-old Turkish children and adolescents. *Eur J Pediatr*; 167(4): 383-389.
12. Taheri M, Kajbaf TZ, Taheri MR, Aminzadeh M. (2016). Neck circumference as a useful marker for screening overweight and obesity in children and adolescents. *Oman Med J*; 31(3): 170-5.
13. Hatipoglu N, Mazicioglu MM, Kurtoglu S, Kendirci M. (2010). Neck circumference: an additional tool of screening overweight and obesity in childhood. *Eur J Pediatr* ; 169(6): 733-739.
14. Laakso M, Matilainen V, Kiukaanniemi KS.(2002). Association of neck circumference with insulin resistance-related factors. *Int J ObesRelatMetabDisord* ; 26(6): 873-875.

CITATION OF THIS ARTICLE

R Moorthi, D.Kalaiselvan, Mohammed Faizal P, K.V.Pugalendhi Raja, B.Pradeep Raj. Neck Circumference measurement As a screening tool For Overweight and Obesity In Children. *Bull. Env.Pharmacol. Life Sci., Spl Issue [1] 2022* : 359-363