

## NECK CIRCUMFERENCE AND SKINFOLD THICKNESS AS PREDICTORS OF OVERWEIGHT & OBESITY AMONG PRIMARY SCHOOL CHILDREN FROM SOUTHERN TAMIL NADU – A CROSS SECTIONAL STUDY

Poihai A<sup>1</sup>, Mahalakshmi M<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Physiology, Government Medical College, Virudhunagar, Tamil Nadu, India

<sup>2</sup>Tutor, Department of Physiology, Government Theni Medical College, Theni, Tamil Nadu, India

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Corresponding Author:

**Dr. Poihai A,**

Email: drpoihai@yahoo.com

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### ABSTRACT

**Background:** Overweight and Obesity in early childhood is on increase and is of great concern because of the relationship between childhood obesity and metabolic complications. Incidence of obesity between the ages of 5 and 14 years was 4 times higher in children who have been overweight at the age of 5 years compared with those of normal weight at that age. Upper body adiposity is considered to be a significant determinant of metabolic and cardiovascular risk. So Neck circumference and Skin fold thickness are used as reliable measurements for upper body adiposity. The aim is to correlate neck circumference and skin fold thickness with body mass index among Primary School children in Virudhunagar. **Materials and Methods:** This cross-sectional study was conducted in 50 school-going children between age 5 to 6 years. Anthropometric measurements – Height & Weight, Neck circumference and Skin fold thickness were measured. Body mass index was Calculated. Pearson's correlation was used as tests of significance to analyze quantitative data. **Result:** Positive correlation of neck circumference and Skin fold thickness with body mass index was observed with Pearson's correlation. Neck circumference ( $r=0.4221$ ,  $p<0.002263$ ) and Skin fold thickness ( $r=0.4727$ ,  $p<0.000528$ ) with BMI were found to be statistically significant. **Conclusion:** Neck circumference and Skin fold thickness may be used as reliable parameters in clinical practice and epidemiological studies as indices of overweight/ obesity among school-going children.

## INTRODUCTION

Overweight (BMI 25–29.9 kg/m<sup>2</sup>) and obesity (BMI  $\geq 30$  kg/m<sup>2</sup>) in early childhood are increasing globally and are of substantial concern due to their strong association with adverse metabolic outcomes. During infancy, body fat rises rapidly and then declines, reaching a nadir around 5–6 years of age. At this stage, adiposity typically rebounds and continues to increase through later childhood, a trajectory linked to elevated future cardiometabolic risk. Notably, the incidence of obesity between 5 and 14 years of age is reported to be approximately four times higher among children who were overweight at age five compared with those of normal weight at that age. These patterns underscore the need for ongoing surveillance of childhood adiposity.<sup>[1,2]</sup>

Body mass index (BMI) is widely used to assess overall adiposity and to classify overweight and obesity; however, BMI does not capture fat distribution, which is a key determinant of metabolic

risk. Central and upper-body fat depots are particularly implicated in insulin resistance, dyslipidaemia, and cardiovascular risk. In this context, neck circumference (NC) and skinfold thickness (SFT) have emerged as simple, low-cost, and feasible anthropometric measures that reflect upper-body adiposity. Evidence suggests that NC and SFT may serve as useful screening indicators for cardiometabolic risk in paediatric populations, potentially complementing BMI in risk stratification.<sup>[3,4]</sup>

### Aims and Objectives

#### Aim

- To evaluate the utility of neck circumference and skinfold thickness as anthropometric indicators in relation to BMI among children aged 5–6 years.

#### Objectives

- To measure neck circumference and skinfold thickness in a sample of 50 apparently healthy children aged 5–6 years.

- To assess the association between neck circumference, skinfold thickness, and body mass index in these children.

## MATERIALS AND METHODS

**Study design and setting:** This cross-sectional study was conducted at a primary school in a southern district of Tamil Nadu, India.

**Participants:** The sample comprised 50 apparently healthy children (25 boys and 25 girls) aged 5–6 years enrolled at the study school.

Exclusion criteria included neck deformity, cervical lymphadenopathy, goitre, chronic medical disorders, and Cushing's disease.

**Ethics:** The study received approval from the Institutional Ethics Committee. Written informed consent was obtained prior to enrolment from the parents.

### Anthropometric measurements

- Weight was measured to the nearest 100 g using a calibrated digital scale, with participants wearing light clothing and no shoes.
- Height was measured barefoot to the nearest 0.5 cm using a portable stadiometer.
- Body mass index (BMI) was calculated as weight (kg) divided by height squared (m<sup>2</sup>) using Quetlet's index.

### Neck circumference

- Neck circumference (NC) was measured with participants standing upright, head in the Frankfort horizontal plane, and shoulders relaxed.
- A non-stretchable plastic measuring tape was positioned perpendicular to the long axis of the neck at the level of Laryngeal prominence
- Two readings were taken, and the average was used for analysis.

### Skinfold thickness

- Skinfold thickness (SFT) was assessed using calibrated skinfold callipers according to the Durnin and Womersley four-site protocol (triceps, biceps, subscapular, and suprailiac).
- All measurements were taken on the right side for consistency.
- The skinfold was grasped between the thumb and index finger of the left hand, lifting the fold approximately 1 cm to include skin and subcutaneous fat.
- The callipers were applied at 90 degrees to the skinfold; readings were recorded in millimetres 2 seconds after application.
- Each site was measured twice, and the average of the two readings was used. The four-site sum was calculated for analysis.

## RESULTS

Pearson's correlation coefficient test was applied to evaluate the correlation and a p value < 0.05 was considered to be statistically significant.

**Table 1: Descriptive Statistics**

Variable	Mean	Standard deviation
Height	112.9 cm	5.334
Weight	20.31 Kg	3.223
BMI	16.552	1.8868
Neck circumference	25.562 cm	1.8974
Skinfold thickness	24.26 mm	1.8273

**Table 2: Reference range of WHO Age BMI growth charts**

BMI	Inference
12 – 14	Underweight
14.1 – 17	Healthy
17.1 – 19	Overweight
>19	Obese

**Table 3: Classification as Overweight and Obesity**

	Boys (n = 25)	Girls (n = 25)	Total (n = 50)
Under weight	1 (4%)	2 (8%)	3 (6%)
Healthy	13 (52%)	16 (64%)	29 (58%)
Overweight / Obese	11 (44%)	7 (28%)	18 (36%)
Total	25 (100%)	25 (100%)	50 (100%)

**Table 4: Normal reference values by Standard tables**

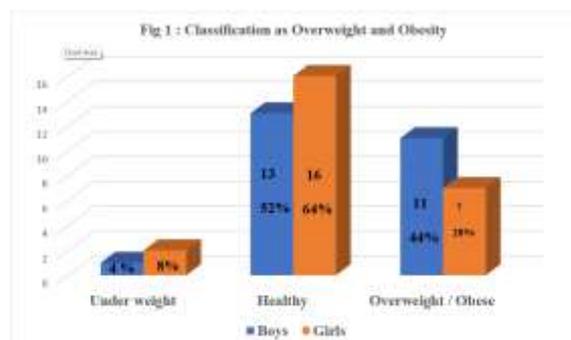
Variable	Boys	Girls
Neck Circumference	26 Cm	25 Cm
Skinfold Thickness	24 Cm	27 Cm

**Table 5: Prevalence of Elevated Neck Circumference and Skinfold Thickness**

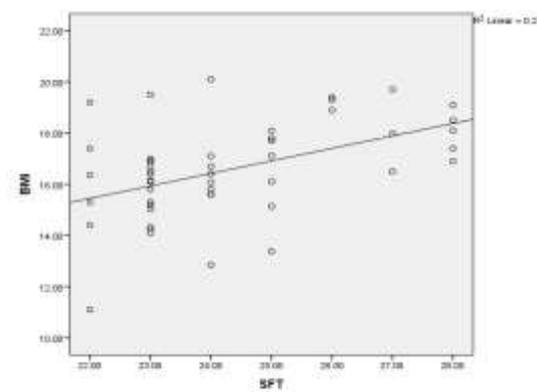
		Boys (n = 25)	Girls (n = 25)
Increased Neck Circumference	Apparently Healthy Children (n = 50)	15 (30%)	9 (18%)
	Overweight/obese	9 (50%)	7 (38.8%)
Increased Skinfold Thickness	Apparently Healthy Children (n = 50)	7 (14%)	5 (10%)
	Overweight/obese	6 (33.3%)	4 (22.2%)

**Table 6: Correlation between BMI with Neck Circumference and Skin Fold thickness**

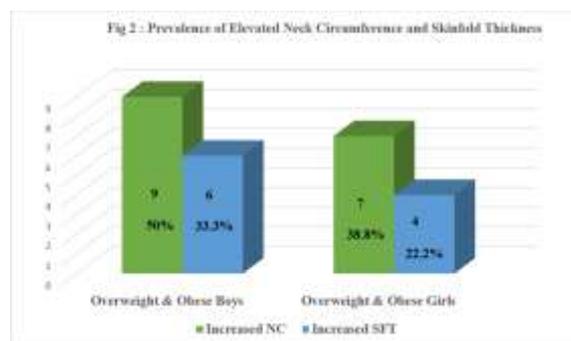
	r value	p value	Statistical Significance
BMI & Neck Circumference	0.4221	0.002263*	Statistically Significant
BMI & Skin fold thickness	0.4727	0.000528*	Statistically Significant



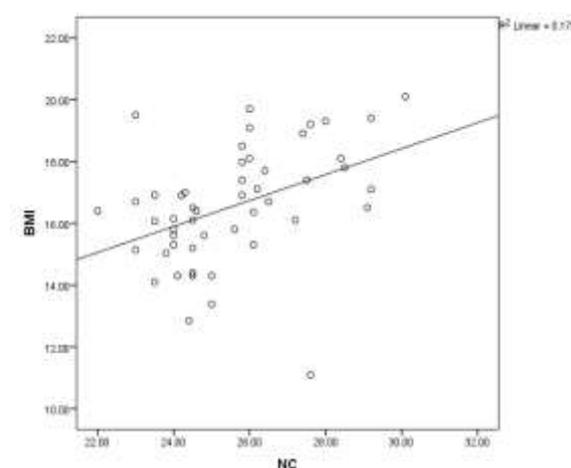
**Figure 1: Classification as Overweight and Obesity**



**Figure 4: Regression analysis by scatter plots**



**Figure 2: Prevalence of Elevated Neck Circumference and Skinfold Thickness**



**Figure 3: Regression analysis by scatter plots**

## DISCUSSION

Obesity is defined as an abnormal accumulation of adipose tissue and is increasingly common among children as well. It is often diagnosed using the Body Mass Index (BMI), though this measure has limitations. While BMI provides a general indication of excess weight, it does not differentiate between weight contributed by muscle and that contributed by fat. Therefore, BMI values should be interpreted with caution.

A significant proportion of body fat is located beneath the skin, and skinfold thickness measurement offers a quick, non-invasive method to assess subcutaneous fat. Another useful marker is neck circumference (NC), which reflects the distribution of upper body subcutaneous adipose tissue. Upper body obesity, in particular, is more strongly linked with metabolic risks such as glucose intolerance and hypertriglyceridemia. Hence, NC can serve as a practical index for identifying overweight and obesity.

Among 50 children aged 5–6 years, the mean (SD) anthropometric values were shown in [Table 1]. As expected, BMI, NC, and SFT were higher among children classified as overweight/obese, with group means of 18.20 kg/m<sup>2</sup>, 27.11 cm, and 25.44 mm, respectively.

[Table 2] shows the Reference range of WHO Age BMI growth charts. WHO Classified Children with BMI 17.1 to 19 as Overweight and BMI > 19 as Obese.

Among the 50 Children, 11 boys (44%) and 7 girls (28%) were classified as Overweight and Obese, as

shown in Table 3 and Figure 1, reinforcing the fact that Obesity is common among Children.

Out of the 50 apparently healthy children, 15 boys (30%) and 9 girls (18%) had higher Neck Circumference. 9 boys (18%) and 7 girls (38.8%) had higher Neck Circumference among Overweight and Obese Children as shown in [Table 5]

Also 7 boys (14%) and 5 girls (10%) had higher Skin fold thickness among apparently healthy Children. 6 boys (33.3%) and 4 girls (22.2%) had higher Neck Circumference among Overweight and Obese Children as shown in [Table 5 and Figure 2]

Positive correlation of neck circumference and Skin fold thickness with body mass index was observed with Pearson's correlation. Neck circumference ( $r=0.4221$ ,  $p<0.002263$ ) and Skin fold thickness ( $r=0.4727$ ,  $p<0.000528$ ) with BMI were found to be statistically significant.

This was reinforced by regression analysis done by Scatter plots as shown in [Figure 3 & 4].

## CONCLUSION

In this study, neck circumference and skinfold thickness showed a strong correlation with BMI. Both neck circumference and skinfold thickness are simple, safe, inexpensive, non-invasive, practical, reliable, and easily measurable tools, similar to BMI. Therefore, in epidemiological studies and clinical practice, these parameters can serve as complementary or alternative measures for the early identification of adiposity and childhood obesity. Neck circumference and skinfold thickness may thus be considered as reliable indices of overweight and obesity among school-going children.

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