ORIGINAL RESEARCH

A study of Tri-ponderal Mass Index (TMI) as a screening tool for risk of central fat accumulation in children

[1]Dr. Siva Saranappa SB, [2]Dr. Girish N, [3]Dr. Sai Bhavani Manchineni, [4]Dr.Afroza, [5]Dr. Madhu GN

[1,2]Associate Professor, Department of Pediatrics, Kempegowda Institute of Medical Sciences Hospital and Research Centre, Bangalore, Karnataka, India
[3,4]Junior Resident, Department of Pediatrics, Kempegowda Institute of Medical Sciences Hospital and Research Centre, Bangalore, Karnataka, India
[5]Professor, Department of Pediatrics, Kempegowda Institute of Medical Sciences Hospital and Research Centre, Bangalore, Karnataka, India

Corresponding Author
Dr. Madhu GN
Professor, Department of Pediatrics, Kempegowda Institute of Medical Sciences Hospital and Research Centre, Bangalore, Karnataka, India
Email: drgnmadhu@gmail.com

Received: 10 February, 2023 Accepted: 15 March, 2023

ABSTRACT
This is a observational, analytical study conducted in urban private schools of Bengaluru in North and South Zone. The children between the age group of 6 years to 15 years were the subjects of the study. It involved recording of anthropometric parameters like weight, height, waist circumference, chest circumference and head circumference. The BMI is calculated from the measures of weight and height, and the TMI by the ratio of weight in kilograms to height in meters at the third power (TMI =W/H3). The risk classification of central fat accumulation is based on the ratio of waist circumference to height. Statistical analysis was done.Among the 979 children studied in our study,511(52%) were boys and 467(48%) were girls. The weight ranged from 15 kgs to 108.4 kgs with mean weight being 42.4 kg. BMI and TMI were found to be higher in adolescent age groups (11 to 15 years). The present study shows high correlation between BMI and TMI ($p<0.001$), in the analysis of its accuracy, through the ROC curves, the TMI shows a higher capacity (AUC-0.911). Thus, TMI is a better indicator of possible future risk of cardio-metabolic disease. TMI is a better tool, superior to BMI, and can early identify children with risk of cardiovascular and metabolic syndrome in a primary health care setting.

Key words: Central obesity, BMI, TMI, WHtR

INTRODUCTION

Overweight and obesity continue to grow in adults and children.The prevalence of childhood obesity is a significant health problem due to its alarming progress.

Worldwide obesity has nearly tripled since 1975. From 1975 to 2016, the prevalence of overweight or obese children and adolescents aged 5-19 years increased more than four-fold. While just under 1% of children and adolescents aged 5-19 years were obese in 1975, more than 124 million children and adolescents were obese in 2016.[1]

Childhood obesity is now an epidemic in India. With 14.4 million obese children, India has the second highest number of obese children in the world, next to China. The prevalence of overweight and obesity in children is 15%.

In private schools catering to upper-income families, the incidence has shot up to 35-40%, indicating a worrying upward trend.[2]

The fundamental cause of childhood obesity is an imbalance between calories consumed and energy spent. Indians are genetically predisposed to obesity. However, the rapid increase in childhood obesity is largely due to environmental influences. Economic prosperity leads to a change in diet from traditional tomodern foods, rich in fat and sugar. Urbanization leads to an increase in sedentary lifestyles and a decline in physical activity.[3]

Childhood obesity has serious health implications. Obese children are at increased risk of hypertension,

osteoarthritis, high cholesterol and triglycerides, Type 2 diabetes, coronary heart disease, stroke, gallbladder disease, respiratory problems, emotional disturbances, and cancers. Two in three obese children will remain obese as adults and at risk for adult lifestyle diseases.[4] Due to the association between excess body fat and the increased risk of developing coronary diseases, interest in quantifying the different compartments of the human body has increased too.

METHODOLOGY

Source OF DATA: The study was conducted in urban private schools after obtaining consent from school. The children between the age group of 6 years to 15 years were the subjects of the study.

STUDY DESIGN: Observational, analytical study which involved recording of anthropometric parameters like weight, height, waist circumference, chest circumference and head circumference.

INCLUSION CRITERIA

- Children from 6 years to 15 years of age from selected urban private schools in Bengaluru.

EXCLUSION CRITERIA

- Children with chronic diseases, major congenital malformations, or specific growth diseases.
- Children whose parent did not authorize participation.

Method OF COLLECTION OF DATA AND METHODOLOGY

1. Children are weighed on portable digital electronic scales, with a capacity of 150kgs and precision of 100g, without shoes.
2. For stature, portable stadiometer, in cm and mm is used. In the measurement, children are made to place their heels, calves, buttocks and shoulders against the wall, positioning the head horizontally to the Frankfurt plane.
3. Waist circumference measured at the approximate midpoint between the lower margin of the last palpable rib and the top of iliac crest.

SAMPLE SIZE:979 children between the age group of 6 to 15 years.

RESULTS

The association between TMI and gender has been represented in Figure 1.There is statistically significant difference in TMI values between males and females($p<0.001$). Females presented with higher TMI values.

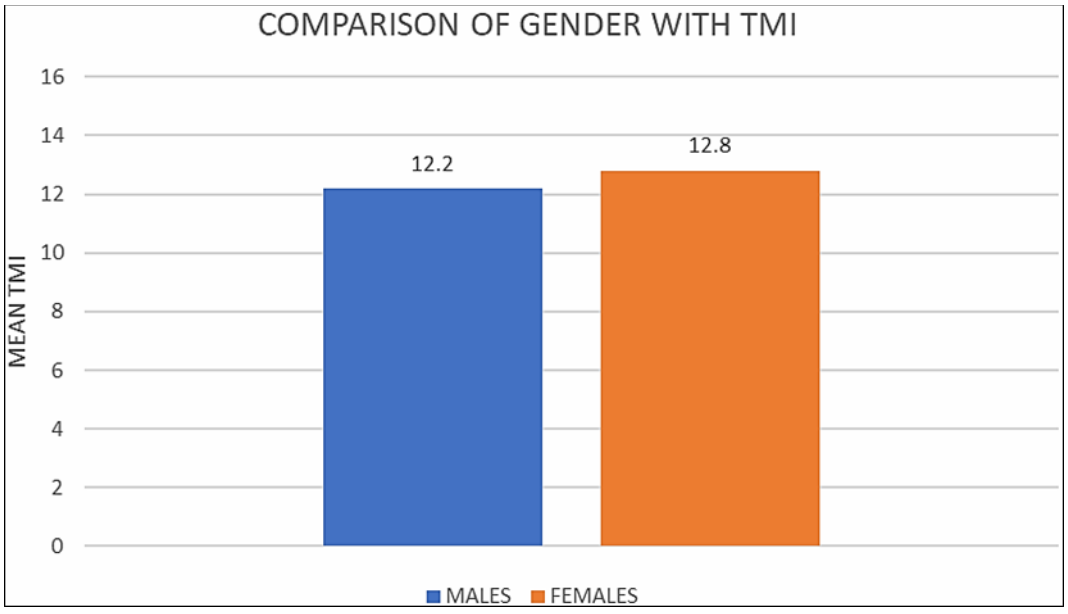

Figure 1: Comparison of Gender with TMI

The association between TMI and age have been represented in Figure 2. Children in the age group 11-15 years were found to have significantly higher TMI than children in age group 6-10 years($p<0.001$).

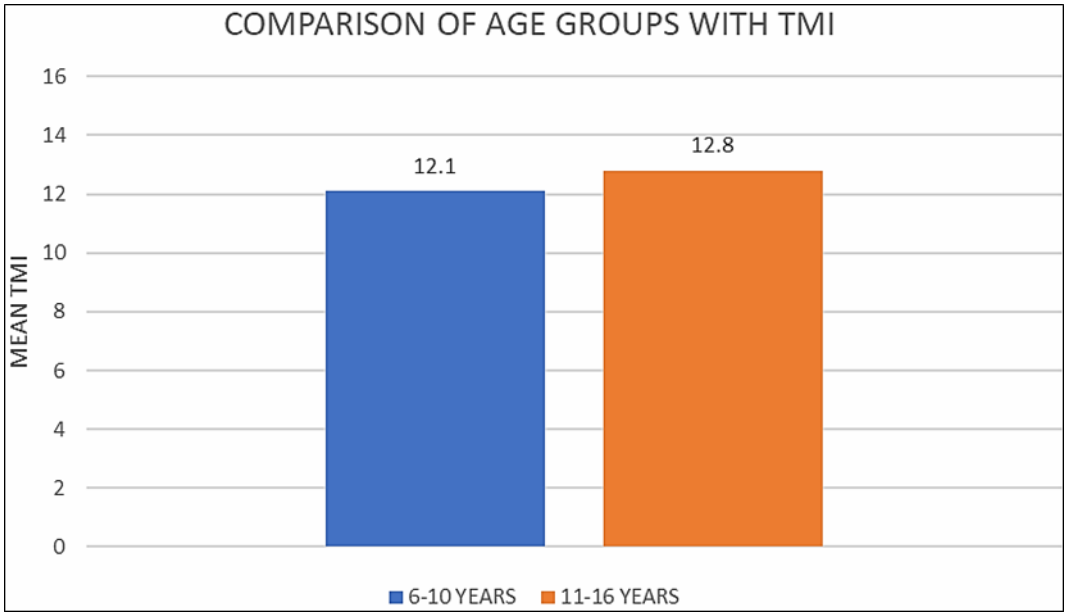

Figure 2: Comparison of Age Groups with TMI

Table 1: Sensitiivity and Specificity of Cutoff Points of the Tri-Ponderal Mass Index (TMI) According to Receiver Operator Characteristics Curve to Screen Risk of Central Fat Excess

Cut off of TMI	Sensitivity (CI 95%)	Specificity (CI 95%)	Diagnostic accuracy
(>= 10)	98.98%	19.39%	43.21%
(>= 11)	98.63%	39.80%	57.41%
(>= 12)	93.52%	64.29%	73.03%
(>= 13)	83.28%	82.94%	83.04%
(>= 13.5)	73.04%	89.36%	84.47%
(>= 14)	64.51%	94.46%	85.50%
(>= 15)	45.73%	98.10%	82.43%
(>= 15.5)	36.86%	98.69%	80.18%
(>= 16)	30.03%	99.42%	78.65%
(>= 17)	13.99%	99.85%	74.16%

In the isolated analysis of the ROC curve of TMI, taking into account the sensitivity and specificity, it can be observed that the cutoff point of10 kg/m3 showed high sensitivity(98.98%), while the cutoff point of 17kg/m3 had high specificity (99.85%) and diagnostic accuracy is highest for TMI of 14 kg/m3.

DISCUSSION

Globally, in 2020, an estimated 39 million children under the age of 5 years were overweight or obese. Over 340 million children and adolescents aged 5 to 19 years were obese in 2016 1.

As per Indian national family health survey-5, overweight among children less than 5 years increased from 2.1% to 3.4% 2.

Obesity is an important paediatric public health problem associated with riskof complications in childhood and increased morbidity and mortality throughout adult life. However, central obesity is more strongly correlated with metabolic risk factors. A number of studies have shown that central obesity is an independent risk factor for type 2 Diabetes Mellitus, dyslipidemia, systemic arterial hypertension, coronary artery disease.

According to the study done by Cornelia Leontine Van Vuuren*etal*., adolescents with overweight or obesity reported psychosocial problems and suicidal thoughts more often. Several studies have concluded that overweight negatively influences social status and that individuals with overweight had fewer friends and were more disliked and more often excluded by their peers. Such social damage can make adolescents with overweight morevulnerable to being victimised due to lack of friends to defend them, lower self-esteem and lower social status among their peer 5.

Study conducted by Nan Wu *et al*., corroborated that childhood obesity was associated with poor academic performance6.

Thus, it is important to identify children who are at increased risk of developing co-morbidities associated with obesity to intervene and prevent the development of chronic diseases including type 2 Diabetes mellitus, cardiovascular disease and to prevent psychosocial problems in children.

In the present study, TMI estimates body fat levels in boys better than girls, where AUC of TMI of boys and girls was 0.92 (95% CI: 0.921-0.962) and 0.880(95% CI: 0.846-0.913),respectively. These findings corroborates with the study done by Courtney M. Peterson *et al.* where TMI better estimates body fat levels, especially in boys 7.

A systemic meta-analysis done by Ashwell,Gunn, and Gibson showed that waist circumference-to-height ratio had a predictive capacity for metabolic risk and development of cardiovascular disease than the isolated measure of waist circumference, for both the sexes.[8]

Our study supports the feasibility of using TMI as a valid instrument to screen children with obesity due to central fat accumulation. Thus, different cutoff values of TMI were analyzed. Among these, the cutoff point that had a highest value of sensitivity and specificity corresponded to a TMI of 14kg/m3 (diagnostic accuracy of 85.5 %).[9]

Considering primary care, the goal of using TMI as a screening instrument for nutritional assessment should emphasize sensitivity, in order to enable the early start of care to prevent future metabolic and cardiovascular diseases.[10]

Thus, our study indicates that a better cutoff point for screening, regardless of age or gender would be a TMI of 10 kg/m3.

However, these values need to be tested in the primary health care of school children before proposing their use in the routine care of this age group.

CONCLUSION

Specific cutoff point for TMI can be established making TMI as a useful screening tool in primary health care, general paediatric clinical practice and in epidemiological studies on childhood obesity.

REFERENCES

1. World Health Organisation. Fact sheet: Available at:www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.Accessed on 9 December 2021.
2. Indian National FamilyHealthSurvey(NFHS-5)Factsheet:Availableat:http://rchiips.org. Accessed on 10 December 2021.
3. Sheila Gahagan.Overweight and Obesity. In KliegmannR. Nelson Textbook of Pediatrics.1st South Asia ed.: Elsevier India; 2016. p.307.
4. Elizabeth KE. Obesity, Metabolic Syndrome and Fatty Liver disease. In Nutrition and Child Development.5th Edition: Paras India; c2019.p.264.
5. Cornelia LeontineVan Vuuren, GustaG Wachter,Rene Veenstra, Judith JM Rijnhart, Marcel F Van der Wal, Mai JM Chinapaw, Vincent Busch.Associations between overweight and mental health problems among adolescents, and the mediating role of victimization. BMC Public Health. 2019;19:612.
6. Wu N, Chen Y, Yang J, Li F. Childhood Obesity and Academic Performance:The Role of Working Memory. Front. Psychol.2017;8:611.
7. Peterson CM, Su H, Thomas DM, HeoM, GolnabiAH, PietrobelliA, *et al.* Tri-Ponderal Mass Index vs. Body Mass Index in Estimating Body Fat During Adolescence. JAMA Pediatr. 2017;171:629-636.
8. AshwellM, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: Systemic review and meta-analysis.Obes.Rev. 2012;13:275-286.
9. Vanderwall1 C, Clark RR, EickhoffJ, CarrelAL. BMI is a poor predictor of adiposity in young overweight and obese children. BMC Pediatr. 2017;17:135.
10. Cole T. Weight-stature indices to measure underweight, overweight, and obesity. In:Himes JE, ed.Anthropometric Assessment of Nutritional Status. New York, NY: Wiley-Liss; c1991. p. 83-111.