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CAROTID INTIMA -MEDIA THICKNESS IN ADOLESCENT CHILDREN (10-18 YEARS) IN NORMAL AND OBESE CHILDREN- A PROSPECTIVE OBSERVATIONAL STUDY.

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ABSTRACT

Obesity among adolescents is a growing global concern associated with significant cardiovascular health risks, including hypertension, diabetes, and atherosclerosis. Carotid Intima-Media Thickness (CIMT), a non-invasive marker of early atherosclerosis, has emerged as a critical tool for assessing vascular health in pediatric populations. Elevated CIMT in obese adolescents reflects early structural changes in arterial walls, indicating heightened cardiovascular risk in later life. Early detection through CIMT measurement allows for targeted interventions to mitigate long-term cardiovascular complications.

Study Objectives:

- To assess the influence of body mass index on the CIMT in healthy and obese adolescent children (10-18 years).
- To compare CIMT of obese children and normal BMI children.

Materials and Methods: This prospective observational study aimed to investigate the relationship between body mass index (BMI) and CIMT in adolescents aged 10-18 years. Conducted at Chettinad Hospital and Research Institute, the study included 100 adolescents categorized into two groups: 50 with normal BMI and 50 classified as obese based on Indian Academy of Paediatrics' growth charts. Data collection involved comprehensive medical histories, physical examinations, and CIMT assessments using high-resolution B-mode ultrasound. Statistical analyses included comparative assessments of CIMT values between BMI groups and correlation analyses between BMI and CIMT, adjusting for potential confounders.

Results: Obese adolescents exhibited significantly higher BMI values (27.4 ± 7.1) and waist circumference (65.1 ± 6.6 cm) compared to their normal BMI counterparts. CIMT measurements revealed notably thicker intima layers in obese adolescents: 0.67 ± 0.2 mm on the right and 0.66 ± 0.2 mm on the left, compared to 0.46 ± 0.19 mm on both sides in normal BMI adolescents. Metabolic profiles indicated poorer glycemic control (HbA1c: 5.28 ± 0.8 vs. 4.78 ± 0.48) and higher total cholesterol levels (147.01 ± 33.1 vs. 134.88 ± 27.11 mg/dL) in the obese group.

Discussion: The study underscores the association between obesity and increased CIMT, highlighting early vascular changes in obese adolescents. Elevated CIMT reflects early endothelial dysfunction and arterial stiffness, indicating predisposition to future cardiovascular diseases such as coronary artery disease and stroke. These findings emphasize the importance of early intervention strategies targeting obesity and metabolic health to mitigate long-term cardiovascular risks in adolescents.

Conclusion: Obesity exerts a significant impact on cardiovascular health in adolescents, as evidenced by increased CIMT and adverse metabolic profiles. Early detection through CIMT measurement provides valuable insights into vascular health, enabling timely interventions to prevent or delay the onset of cardiovascular complications. Future research should focus on longitudinal studies to further elucidate the progression of obesity-related vascular changes and evaluate the efficacy of intervention strategies in reducing cardiovascular risk in this vulnerable population.

Key Words: Obesity, Carotid Intima-Media Thickness (CIMT), Adolescent, Cardiovascular health

INTRODUCTION

Obesity has reached epidemic levels globally, affecting both developed and developing countries. Over 1 billion adults are overweight, with 300 million classified as clinically obese (1). The prevalence of obesity among adolescents is increasing at an alarming rate globally, posing serious implications for cardiovascular health. According to the World Health Organization (WHO), the proportion of overweight or obese children and adolescents aged 5-19 has surged from four percent in 1975 to over eighteen percent in 2016 (2). This trend is particularly concerning as obesity during adolescence is strongly associated with heightened risks of hypertension, diabetes, and atherosclerosis (3). In India, the prevalence of obesity among adolescents has significantly risen. Recent data reveals that around 12% of Indian children aged 5-19 are overweight or obese, with higher rates observed in urban areas compared to rural regions (4). A 2019 study further indicated that obesity rates among adolescents in India continue to rise, highlighting the urgent need for public health interventions (5).

Adolescents are particularly vulnerable to developing cardiovascular diseases (CVDs) due to obesity. Early-life obesity can accelerate the progression of atherosclerosis, a condition marked by the buildup of fatty deposits in arterial walls. This pathological process can begin in childhood and adolescence, leading to increased risks of myocardial infarction and stroke in later life (6). Research has demonstrated that overweight and obese adolescents exhibit early markers of cardiovascular risk, such as elevated blood pressure, dyslipidaemia, and insulin resistance, which are predictors of future cardiovascular events(7). Obesity in adolescence is associated with a higher likelihood of coronary heart disease in adulthood, highlighting the long-term health consequences (8). Obesity in adolescents also significantly increases the risk of developing CVDs in early adulthood, underscoring the importance of early intervention (9)

Early detection and intervention strategies are crucial in mitigating the long-term impact of obesity on cardiovascular health. Identifying vascular changes early, through markers like Carotid Intima-Media Thickness (CIMT), enables targeted interventions to prevent or delay the onset of CVDs in adulthood. Research suggests that CIMT can reveal early signs of arterial thickening and endothelial dysfunction, which are precursors to more severe cardiovascular events (10). Increased CIMT is significantly associated with other cardiovascular risk factors, supporting its potential as a screening tool for early intervention (11).

CIMT is a reliable predictor of future cardiovascular events, underscoring its clinical utility (12). CIMT is a significant non-invasive measurement technique that assesses structural changes in the carotid artery walls. Its utility in detecting early signs of vascular damage associated with obesity, such as arterial thickening and endothelial dysfunction, is well-documented (13). Studies have shown that increased CIMT in obese adolescents correlates with higher levels of inflammatory markers and endothelial dysfunction, highlighting its role in early detection of cardiovascular risk (14). CIMT measurement is also a reliable predictor of myocardial infarction and stroke, making it a valuable tool for clinical practice (15).

Understanding variations in CIMT among obese adolescents has broader implications for both research and clinical practice. By investigating the influence of body mass index (BMI) on CIMT in healthy and obese adolescent children aged 10-18 years, this study aims to provide insights into how obesity impacts vascular health from an early age.

MATERIALS AND METHODOLOGY:

This non-interventional, prospective observational study was conducted at the Chettinad Hospital and Research Institute, a tertiary care center. The study aimed to examine the relationship between body mass index (BMI) and CIMT in adolescents aged 10-18 years. The study population consisted of 100 adolescents, divided into two groups: 50 children with normal BMI and 50 obese children, classified based on the Indian Academy of Paediatrics' (IAP) growth charts.

Inclusion criteria included adolescents aged 10-18 years attending the pediatric outpatient department (OPD) or admitted to the pediatric ward for minor ailments such as simple viral fever or upper respiratory infections. Exclusion criteria covered critically ill children, those with conditions or medications that could affect body composition, insulin action, or insulin secretion (e.g., Statins, beta-blockers, loop diuretics, thyroxine, glucocorticoid therapy, Cushing's syndrome, hypothyroidism), and children with a strong family history of dyslipidaemia, hypertension, or diabetes.

Data collection involved enrolling patients after obtaining informed consent from parents or guardians. A brief medical history, including age, gender, gestational age, and birth weight, was recorded, followed by a thorough physical examination. Anthropometric measurements were conducted using standardized equipment: height to the nearest 0.1 cm and weight to the nearest 0.1 kg, with BMI calculated as weight (kg) divided by height (m^2) and percentiles determined using the revised IAP 2015 charts. Waist circumference (WC) was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, hip circumference (HC) at the widest part of the buttocks, and the waist-hip ratio (WHR) calculated as WC/HC. Blood pressure (both systolic and diastolic) was measured after the child had been seated for at least 5 minutes using a calibrated sphygmomanometer.

Measurements

CIMT measurement was performed using a high-resolution B-mode ultrasound machine. After a 10-minute rest period, the patient was positioned supine with the head slightly turned to each side during the examination. A single trained and blinded physician conducted the ultrasound, obtaining longitudinal 2D images of the distal 1 cm of the far wall of both the right and left common carotid arteries. The intima-media complex, visualized as two echogenic lines representing the lumen-intima and media-adventitia interfaces, was measured. A minimum of four measurements were taken at each site, with the maximum value recorded for statistical analysis. All measurements were completed on an outpatient basis on the same day to ensure consistency.

Data Analysis

For data analysis, descriptive statistics summarized the baseline characteristics of the study population. Comparative analyses of CIMT values between the normal BMI and obese groups were performed using t-tests or non-parametric tests as appropriate. Correlation analyses examined the relationship between BMI and CIMT, and multivariate regression analyses adjusted for potential confounders such as age, gender, blood pressure, and waist-hip ratio.

Ethical Consideration

Ethical considerations included approval from the Institutional Ethics Committee of Chettinad Hospital and Research Institute, obtaining written informed consent from parents or guardians, and ensuring confidentiality and anonymity of participant data. The study period spanned from October 2022 to July 2023, with a total sample size of 100 adolescents. The study utilized high-resolution B-mode ultrasound machines and standardized anthropometric tools to ensure accurate and reliable data collection. This rigorous methodology provided valuable insights into the impact of obesity on cardiovascular health in adolescents.

RESULTS

The current study focused on assessing carotid intima-media thickness (CIMT) and associated health parameters in adolescents aged 10-18 years, specifically comparing those with normal

BMI to obese individuals. The mean age of the participants was 12.91 years, with a median age of 12.00 years and a standard deviation of 2.43 years, indicating a relatively homogeneous age distribution across the cohort. Gender distribution was nearly balanced, with 43% male and 57% female participants.

The findings revealed substantial differences in key health indicators between the two groups. Adolescents classified as obese demonstrated significantly higher BMI values (27.4 ± 7.1) compared to those with normal BMI (21.05 ± 1.33). Similarly, waist circumference was markedly elevated in the obese group (65.1 ± 6.6) compared to the normal BMI group (61.4 ± 6.84), indicating a greater accumulation of abdominal fat in these individuals. Carotid intima-media thickness measurements provided further insights into cardiovascular health. The CIMT values were notably higher in obese adolescents compared to their counterparts with normal BMI. Specifically, the right intima thickness was 0.67 ± 0.2 mm in the obese group versus 0.46 ± 0.19 mm in the normal BMI group, while the left intima thickness was 0.66 ± 0.2 mm in the obese group versus 0.46 ± 0.19 mm in the normal BMI group. These differences were statistically significant, underscoring the early onset of vascular changes associated with obesity during adolescence. Metabolic correlations highlighted additional health risks associated with obesity. The obese group exhibited elevated levels of HbA1c (5.28 ± 0.8) compared to the normal BMI group (4.78 ± 0.48), indicating poorer glycaemic control. Furthermore, lipid profiles showed higher total cholesterol levels in the obese group (147.01 ± 33.1) compared to the normal BMI group (134.88 ± 27.11).

FIGURES AND TABLES

Table 1: shows age distribution in the study population

VARIABLE		VALUE
Mean		12.9100
Median		12.0000
Std. Deviation		2.43333
Range		7.00
Percentiles	25	11.0000
	50	12.0000
	75	15.0000

Table 2: shows the gender distribution in the study population

GENDER	FREQUENCY	PERCENT
Male	43	43.0
Female	57	57.0
Total	100	100.0

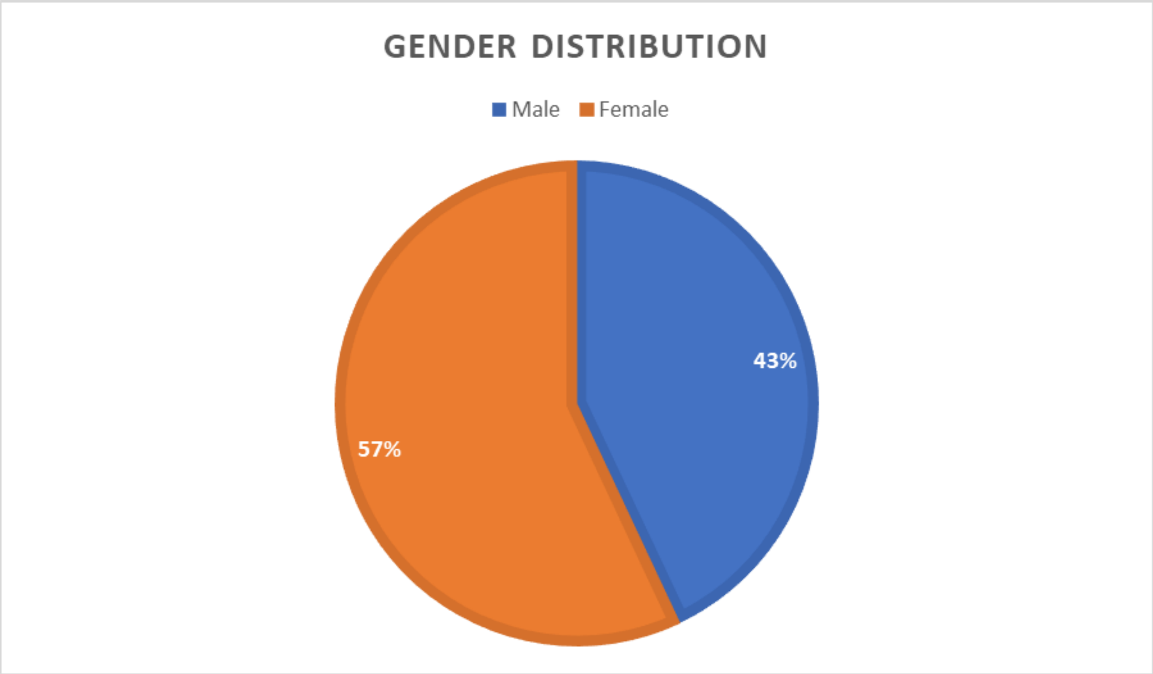

Table 3: shows Descriptive statistics of Normal BMI and Abnormal BMI Health parameter

Variables	**Mean ± SD**	
	BMI-Normal	**BMI-Abnormal**
Gender		
Male	10(37%)	33(45.2%)
Female	17(63%)	40(54.8)
Age	12.9±2.4	12.7±2.5
Health parameter		

Height	158.3±11.45	154.6±11.9
Weight	51.5±10.63	47.7±14.9
Waist Circumference	61.4±6.84	65.1±6.6
Hip circumference	83.4±7.617	81.5±8.8
Waist -Hip Ratio	0.77±0.13	0.79±0.10
BMI	21.05±1.33	27.4±7.1
Hba1c	4.78±0.48	5.28±0.8
FBS	90.88±17.57	95.83±23.3
Lipid Profile(Total Cholesterol)	134.88±27.11	147.01±33.1
Right Intima Thickness	0.46±0.19	0.67±0.2
Left Intima Thickness	0.46±0.19	0.66±0.2

Table 4: shows comparison between Normal and abnormal health parameter

Variables	**Group**	**N**	**Mean Rank**	**Z**	**Asymp. Sig. (2-tailed)**
Height	Normal	27	56.28	-1.212	0.225
	Abnormal	73	48.36		
Weight	Normal	27	57.06	-1.375	0.169
	Abnormal	73	48.08		
Waist Circumference	Normal	27	39.52	-2.309	0.021*
	Abnormal	73	54.56		
Hip circumference	Normal	27	55.17	-0.98	0.327
	Abnormal	73	48.77		
Waist Hip Ratio	Normal	27	46.09	-0.926	0.354
	Abnormal	73	52.13		
BMI	Normal	27	46	-0.943	0.002*
	Abnormal	73	52.16		
Hba1c	Normal	27	37.89	-2.652	0.008*

	Abnormal	73	55.16		
FBS	Normal	27	46.54	-0.832	0.405
	Abnormal	73	51.97		
Lipid profile total cholesterol	Normal	27	43.89	-1.386	0.166
	Abnormal	73	52.95		
Right intima thickness	Normal	27	36.74	-2.943	0.003*
	Abnormal	73	55.59		
Left intima thickness	Normal	27	36.59	-2.964	0.003*
	Abnormal	73	55.64		

Table 5: shows association between abnormal BMI and health parameter

Variables	**Value**	**df**	**Asymp. Sig. (2-sided)**
Height	1.800E3	1632	0.002*
Weight	1635.00	1632	0.003*
Waist Circumference	1.136E3	1104	0.245
Hip Circumference	1235.59	1152	0.0431*
Waist -Hip Ratio	1191.15	1056	0.002*
Hba1c	1031.395	816	0.000*
FBS	1496.50	1200	0.000*
Lipid Profile(Total Cholesterol)	2688.83	2352	0.000*
Right Intima Thickness	444.59	432	0.02*
Left Intima Thickness	444.97	432	0.03*

Table 6: shows correlation between abnormal BMI and health parameter:

Variables	**r**	**Asymp. Sig. (2-sided)**
Height	-0.08	0.483

Weight	0.55	0.000*
Waist Circumference	0.28	0.018*
Hip Circumference	0.12	0.307
Waist -Hip Ratio	-0.02	0.859
Hba1c	0.49	0.000*
FBS	0.35	0.002*
Lipid Profile(Total Cholesterol)	0.60	0.000*
Right Intima Thickness	0.81	0.000*
Left Intima Thickness	0.80	0.000*

DISCUSSION

The study revealed a clear association between BMI and CIMT among adolescents. Obese adolescents showed significantly higher CIMT values compared to their peers with normal BMI, suggesting that increased BMI during adolescence contributes to early vascular changes. This finding aligns with a substantial body of research demonstrating the link between higher BMI and increased CIMT, indicating early atherosclerotic changes. For instance, Charakida et al. found that childhood obesity is associated with adverse vascular phenotypes, including increased CIMT (16). Similarly, Magnussen et al. reported that higher BMI in childhood predicts increased CIMT in adulthood, underscoring the long-term vascular impact of early obesity (17).

The early onset of these vascular changes underscores the importance of managing BMI from a young age to mitigate long-term cardiovascular risks. Childhood obesity is known to initiate the process of atherosclerosis, characterized by the buildup of fatty deposits within the arterial walls. This can lead to the thickening of the arterial walls, as evidenced by increased CIMT, and subsequently heighten the risk for future cardiovascular diseases (CVDs) such as coronary artery disease and stroke (18,19). These early vascular changes are critical indicators of future cardiovascular health, emphasizing the need for early and effective weight management strategies (20).

The study provided substantial evidence that obese children have elevated CIMT values compared to those with normal BMI. Specifically, the CIMT values for both the right and left carotid arteries were significantly higher in the obese group, suggesting early vascular changes associated with obesity. This finding is consistent with other studies that have highlighted the utility of CIMT as a reliable non-invasive marker for early atherosclerosis and cardiovascular risk in pediatric populations. Jourdan et al. established normative values for CIMT and demonstrated that increased CIMT in children is associated with higher cardiovascular risk (21). Furthermore, Juonala et al. confirmed that childhood obesity and related risk factors are linked to increased CIMT in adulthood, reinforcing the long-term health implications (22).

By demonstrating significant differences in CIMT based on BMI status, the study supports the potential of CIMT assessments as a tool for early identification of at-risk individuals, enabling timely interventions. CIMT has been widely used in clinical research as a surrogate marker for atherosclerosis and cardiovascular risk assessment. Elevated CIMT values in obese children, as observed in this study, are indicative of early endothelial dysfunction and increased arterial stiffness, both of which are precursors to more severe cardiovascular conditions (23,24). This underscores the importance of early detection and intervention in preventing the progression of cardiovascular disease from an early age (25). The study found strong positive correlations between abnormal BMI and adverse metabolic profiles, such as elevated HbA1c and total cholesterol levels, among obese adolescents. These metabolic changes further emphasize the systemic impact of obesity, highlighting the interconnected nature of metabolic and cardiovascular health. Elevated HbA1c levels indicate poor glycemic control, which is a known risk factor for CVDs. Similarly, higher total cholesterol levels are linked to increased risk of atherosclerosis and subsequent cardiovascular events (26,27). These findings underscore the need for comprehensive early intervention strategies that target both weight management and metabolic health to reduce the long-term risk of CVDs.

Metabolic syndrome, characterized by a cluster of conditions including increased blood pressure, high blood sugar levels, excess body fat around the waist, and abnormal cholesterol levels, is often associated with obesity. Adolescents with metabolic syndrome are at a higher risk of developing cardiovascular diseases later in life. The study's findings of elevated HbA1c and cholesterol levels among obese adolescents highlight the need for early lifestyle interventions to improve metabolic health and reduce the risk of CVDs (28). Freedman et al. also emphasized that overweight children are more likely to develop adverse metabolic profiles, further increasing their cardiovascular risk (26). Additionally, Zimmet et al. identified metabolic syndrome as a significant concern among obese children and adolescents, stressing the need for early detection and management (29).

In India, the rising rates of obesity among adolescents, particularly in urban areas, call for targeted efforts to promote healthy lifestyles, including balanced diets and regular physical activity (30). Early detection and intervention, such as using CIMT measurements, can play a crucial role in preventing the progression of obesity-related cardiovascular changes. The study's findings reinforce the importance of routine screening for cardiovascular risk factors in obese adolescents. Incorporating CIMT measurements into clinical practice can aid in the early identification of individuals at higher risk of developing CVDs, allowing for timely preventive measures (23). Moreover, addressing metabolic abnormalities through lifestyle modifications and, if necessary, pharmacological interventions can help improve long-term cardiovascular outcomes for obese adolescents .

CONCLUSION

The study underscores the significant impact of obesity on cardiovascular health in adolescents, as evidenced by increased CIMT values and adverse metabolic profiles. These findings highlight the urgent need for early intervention strategies to manage obesity and its associated risks, thereby preventing long-term cardiovascular complications. Future research should focus on longitudinal studies to further elucidate the progression of obesity-related vascular changes and the effectiveness of various intervention strategies in reducing cardiovascular risk in this vulnerable population.

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None

CONFLICT OF INTEREST

None

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