



## Research

# Clinical Significance of Carotid Artery Intima-Media Thickness in Childhood Obesity

## Obezite Hastalığı ile Takipli Olan Hastalardaki İnternal Karotis Arterin İntima Kalınlığının Takip Açısından Önemi

İD Mehmet Emin Mementoğlu<sup>1</sup>, İD Bedir Akyol<sup>2</sup>, İD Figen Palabıyık<sup>3</sup>, İD Bengisu Mementoğlu<sup>4</sup>,  
İD Sadık Sami Hatipoğlu<sup>4</sup>, İD Esra Deniz Papatya Çakır<sup>5</sup>, İD Esra Şevketoğlu<sup>1</sup>

<sup>1</sup>University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Pediatric Intensive Care Unit, İstanbul, Türkiye

<sup>2</sup>University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Pediatric Cardiology, İstanbul, Türkiye

<sup>3</sup>University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Pediatric Radiology, İstanbul, Türkiye

<sup>4</sup>University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Pediatrics, İstanbul, Türkiye

<sup>5</sup>University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Pediatric Endocrinology, İstanbul, Türkiye

### ABSTRACT

**Objective:** This study aimed to investigate the correlation between carotid artery intima-media thickness (c-IMT) and increased body mass index (BMI), particularly in the context of childhood obesity. Furthermore, the study emphasizes the potential utility of c-IMT as a parameter for follow-up and monitoring during diagnosis and management.

**Methods:** This case-control study was conducted at the pediatric endocrinology unit and the well child polyclinic between January and August 2017. A total of 96 children aged 6 to 18 years were included. Anthropometric measurements, including height, weight, and waist circumference, were recorded, and BMI Z-scores were calculated accordingly. Biochemical tests included fasting blood glucose, insulin, total cholesterol, triglycerides, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) levels. c-IMT was measured using B-mode ultrasonography with a 7.5 MHz linear probe, targeting both the common and internal carotid arteries. Morphological features of the artery, including luminal echogenicity and intima-media surfaces, were also evaluated.

**Results:** c-IMT values were significantly higher in obese children compared with the control group. There were no significant differences between the study groups in mean age or gender. When the two groups were compared, there was a significant increase in c-IMT levels among those with high ALT levels compared with those with normal ALT levels. A correlation between high AST levels and c-IMT was observed only in the obese patient group. A threshold of 0.8 mm was set as the upper limit for normal c-IMT values. No patient had a c-IMT measurement above 0.8 mm.

**Conclusion:** This study demonstrates that increased c-IMT in obese children may serve as an early indicator of endothelial dysfunction and preclinical atherosclerosis. Measuring c-IMT could be a non-invasive and practical method for risk stratification and early cardiovascular monitoring in pediatric obesity. Further longitudinal studies are warranted to establish its predictive value.

**Keywords:** Carotid intima-media thickness, childhood obesity, atherosclerosis, cardiovascular risk

### ÖZ

**Amaç:** Bu çalışmanın amacı, çocukluk çağı obezitesinde karotis arter intima-media kalınlığı (k-İMK) ile artmış vücut kitle indeksi (VKİ) arasındaki ilişkiyi değerlendirmektir. Ayrıca, k-İMK'nin tanı ve tedavi sürecinde izlem parametresi olarak kullanılabilirliğine dikkat çekilmesi hedeflenmiştir.

**Gereç ve Yöntem:** Bu olgu-kontrol çalışması, Ocak-Ağustos 2017 tarihleri arasında çocuk endokrinoloji ünitesi ve çocuk sağlığı izlem polikliniğinde yürütülmüştür. Yaşları 6 ile 18 arasında değişen toplam 96 çocuk çalışmaya dahil edilmiştir. Boy, kilo ve bel çevresi ölçümleri alınarak VKİ Z-skorları hesaplanmıştır. Katılımcılardan 8-10 saatlik açlık sonrası alınan örneklerle açlık kan şekeri, insülin, total kolesterol, trigliserit, aspartat aminotransferaz (AST) ve alanin aminotransferaz (ALT) düzeyleri değerlendirilmiştir. k-İMK, B-mod ultrasonografi ve 7.5 MHz lineer prob kullanılarak, hem ortak hem

**Address for Correspondence:** Mehmet Emin Mementoğlu, MD, University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Pediatric Intensive Care Unit, İstanbul, Türkiye

**E-mail:** mementoğlu@hotmail.com **ORCID ID:** orcid.org/0000-0003-3839-4722

**Cite as:** Mementoğlu ME, Akyol B, Palabıyık F, Mementoğlu B, Hatipoğlu SS, Papatya Çakır ED, et al. Clinical significance of carotid artery intima-media thickness in childhood obesity. Med J Bakirkoy. 2026;22(2):142-146

**Received:** 06.10.2024

**Accepted:** 02.09.2025

**Publication Date:** 08.06.2026



## ÖZ

de internal karotis arter seviyelerinde ölçülmüş; arter morfolojisi, lümen ekojenitesi ve intima-media yüzey özellikleri ayrıntılı olarak incelenmiştir.

**Bulgular:** k-IMT değerleri obez çocuklarda kontrol grubuna kıyasla anlamlı derecede yüksekti. Çalışma gruplarının yaş ortalamaları ve cinsiyetleri arasında anlamlı bir fark yoktu. Her iki grupta kendi içlerinde değerlendirildiğinde ALT düzeyi yüksek olanlarda, ALT düzeyi normal olanlara kıyasla k-IMT düzeylerinde anlamlı bir artış vardı. Sadece obez hasta grubunda, yüksek AST düzeyleri ile k-IMT arasında bir korelasyon vardı. Normal k-IMT değerleri için üst sınır olarak 0,8 mm'lik bir eşik belirlenmiştir. Hiçbir hastada k-IMT ölçümü 0,8 mm'nin üzerinde değildi.

**Sonuç:** Bu çalışma, çocukluk çağı obezitesinde k-IMK ölçümünün endotelial disfonksiyon ve preklirik aterosklerozun erken göstergesi olabileceğini ortaya koymaktadır. k-IMK, obez çocuklarda kardiyovasküler riskin non-invaziv ve pratik bir değerlendirme yöntemi olarak kullanılabilir. Bulgular doğrultusunda, bu ölçümün uzun dönem sonuçlarını değerlendirmek amacıyla ileriye dönük, daha geniş örneklemlili çalışmalara ihtiyaç vardır.

**Anahtar Kelimeler:** Karotis intima-media kalınlığı, çocukluk obezitesi, ateroskleroz, kardiyovasküler risk

## INTRODUCTION

Obesity, defined as excessive accumulation of adipose tissue, has become an increasingly prevalent global health concern, particularly among children. Rapid urbanization, sedentary lifestyles, and increased consumption of energy-dense foods have led to a sharp rise in childhood obesity rates (1). In addition to physical health problems, obese children often face social and psychological issues such as stigma, isolation, and depression. They are also at higher risk of developing asthma, obstructive sleep apnea, orthopedic disorders, gastrointestinal disturbances, and cardiovascular and metabolic diseases, including hypertension, dyslipidemia, and insulin resistance (2).

Childhood obesity is a well-established risk factor for vascular changes and the development of atherosclerosis. These changes are primarily mediated by chronic low-grade inflammation, which adversely affects endothelial function and smooth muscle activity (3). Evidence shows that children aged 9 to 12 years may exhibit early signs of vascular impairment, including increased arterial stiffness and increased intima-media thickness (IMT). Among the various diagnostic tools available, carotid artery IMT (c-IMT) measurement by B-mode ultrasonography has emerged as a reliable and non-invasive method for detecting subclinical atherosclerosis (4).

Body mass index (BMI) Z-scores are widely used to categorize obesity severity in children. A Z-score between +2.00 and +2.49 indicates moderate obesity, while a Z-score of +2.50 or higher indicates severe obesity (5). Although childhood obesity is often influenced by multifactorial environmental conditions, genetic predisposition plays a substantial role, with heritability estimates ranging from 25% to 80% (6). Positive family history, limited physical activity, and excessive screen time are well-documented contributors (7).

Despite its growing prevalence, childhood obesity remains an underrecognized problem, especially in terms of its long-term impact (8). It is associated with numerous

complications, including insulin resistance, type 2 diabetes, precocious puberty, menstrual irregularities, infertility, polycystic ovary syndrome, hepatic steatosis, gallstones, orthopedic disorders, and various psychosocial issues (9). Cardiovascular complications such as coronary artery disease, cerebrovascular events, and hypertension are among the most severe and life-threatening consequences (10).

c-IMT measurement is supported by nearly two decades of research as a surrogate marker for atherosclerosis (11). It consists of a hypochoic layer between two echogenic lines, representing the intima and media layers (12). The thickness reflects early vascular changes and correlates well with histological findings (13). Furthermore, c-IMT measurements are reproducible and suitable for longitudinal monitoring, making them ideal candidates for early cardiovascular risk stratification in children (14).

## METHODS

### Study Design and Setting

This research was designed as an epidemiological case-control study. It was conducted at the pediatric endocrinology unit and the well child polyclinic of the children's hospital between January and August 2017. The study protocol was approved by the University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (approval no: 2018-12-13, date: 25.06.2018). Informed consent for participation and publication was obtained from the parents or legal guardians of all participants.

### Statistical Analysis

Statistical analyses were performed using the SPSS (Statistical Package for the Social Sciences) for Windows version 21.0 software package. Continuous variables were expressed as mean±standard deviation (SD) or median (minimum-maximum), while categorical variables were presented as numbers and percentages. Comparisons between two groups were performed using the Mann-Whitney U test for

continuous variables. Categorical variables were compared using the chi-square test or Fisher's exact test. A p-value of  $<0.05$  was considered statistically significant.

### Study Population

A total of 96 children (aged 6-18 years) who presented to the outpatient clinics were included. Participants were divided into two groups based on BMI Z-scores calculated using the World Health Organization (WHO) growth reference data for ages 5-19 years: patient group (BMI Z-score  $\geq +2$  SD) and control group (BMI Z-score  $< +2$  SD).

Anthropometric measurements (height, weight, and waist circumference) were performed using standardized techniques. BMI was calculated as weight (kg)/height<sup>2</sup> (m<sup>2</sup>). Z-scores were determined according to age and sex-specific reference values.

### Laboratory Evaluation

Following an 8-10-hour fast, venous blood samples were collected. If fasting criteria were not met, the participant was asked to return the following day. The following biochemical parameters were measured using standard laboratory techniques: fasting blood glucose (FBG), insulin, total cholesterol, triglycerides, aspartate aminotransferase (AST), alanine aminotransferase (ALT), c-IMT measurement.

Bilateral carotid artery evaluations were performed using B-mode ultrasonography with a 7.5 MHz linear-array transducer. Measurements were obtained from the common carotid artery and internal carotid artery on both the right and left sides. The arteries were assessed for morphological characteristics, including the echogenicity of the arterial lumen and the clarity and thickness of the intimal and medial layers. All measurements were performed by the same radiologist, who was blinded to the participants' clinical status to avoid observer bias.

## RESULTS

A total of 96 children aged between 6 and 18 years were included in the study. Of the participants, 53 (55.2%) were girls and 43 (44.8%) were boys. The mean age was 11.8 years (range: 6-17 years). Anthropometric measurements, including weight, height, and BMI Z-scores, were calculated according to WHO age and sex-specific reference data. According to BMI Z-scores, 52 children were classified as obese (BMI SD score  $\geq +2$ ), and 44 children were classified as controls (BMI SD score  $< +2$ ). No significant differences were found between the study groups in mean age and gender. Routine biochemical evaluations revealed elevated ALT and AST values in both groups. However, elevated ALT values were associated with a simultaneous increase in c-IMT in

both groups. Interestingly, an increase in AST values was associated with an increase in c-IMT values only in the obese group, whereas no such association was observed in the control group. Mean FBG, insulin, total cholesterol, and triglyceride levels were also higher in the obese group. c-IMT values were significantly greater in the obese group than in the control group ( $p < 0.05$ ).

Based on the distribution of values, the upper limit of normal c-IMT was determined to be 0.8 mm. Measurements below this threshold were considered non-pathologic.

## DISCUSSION

This study demonstrated that c-IMT values were significantly higher in obese children compared with their non-obese peers (15). These findings are consistent with previous literature suggesting that obesity during childhood contributes to early vascular changes and the initiation of subclinical atherosclerosis.

Obesity, characterized by excessive adipose tissue accumulation, has been recognized as a chronic metabolic disorder with increasing global prevalence, especially among children and adolescents (16). The associated complications extend beyond physical appearance to include a wide range of metabolic, cardiovascular, and psychosocial outcomes. The accelerated onset of conditions typically associated with adulthood, such as type 2 diabetes, hypertension, dyslipidemia, and hepatic steatosis, highlights the critical need for early detection strategies in this population (17).

Studies have shown that early atherosclerotic changes, including endothelial dysfunction and intimal thickening, can occur even in asymptomatic obese children. These vascular alterations are thought to result from a chronic inflammatory state driven by excess adiposity and metabolic dysregulation (18). Notably, some evidence indicates that these changes may be partially reversible with early lifestyle interventions such as diet modification and physical activity, further emphasizing the importance of early risk assessment (19).

c-IMT measurement, a non-invasive and highly reproducible method, offers a valuable diagnostic window into early vascular health. It correlates strongly with histopathological findings and is increasingly recognized as a surrogate marker for cardiovascular disease risk in both adults and children. In this study, a c-IMT value of 0.8 mm was identified as the upper limit of normal. While this threshold may vary slightly between studies, it provides a practical reference point for identifying children at potential risk (20).

Importantly, the concurrent elevation of AST and c-IMT levels in the obese group suggests an association between

hepatic inflammation and vascular remodeling, which may represent a systemic response to obesity-related metabolic stress. Previous research has similarly linked elevated transaminases with both hepatic steatosis and endothelial dysfunction (20).

The findings of our study support the growing body of evidence that c-IMT measurement should be integrated into the cardiovascular risk assessment of obese pediatric patients (21). It may serve not only as a diagnostic tool but also as a target for monitoring treatment efficacy in clinical practice.

## CONCLUSION

In this study, we found that c-IMT was significantly increased in obese children compared to non-obese controls, supporting its role as an early marker of subclinical atherosclerosis. Additionally, concurrent elevations of AST and ALT in these patients may indicate hepatic involvement as part of a systemic inflammatory process associated with obesity.

Our findings underscore the clinical relevance of c-IMT measurement in pediatric populations, especially for those with elevated BMI. c-IMT assessment, a non-invasive, reliable, and cost-effective method can be incorporated into routine clinical evaluation to stratify cardiovascular risk and guide early interventions in obese children.

Furthermore, in cases where transaminase levels, particularly ALT and AST, are elevated, c-IMT may serve as a complementary tool to abdominal ultrasonography for detecting early vascular changes. The identification of a 0.8 mm threshold as a practical upper limit for normal c-IMT values provides clinicians with a reference point for interpreting results.

c-IMT measurement should be considered during cardiovascular screening of children with obesity, particularly those with elevated liver enzymes.

Early detection of vascular changes via c-IMT can inform timely lifestyle or pharmacologic interventions to prevent long-term complications.

Further longitudinal and multicenter studies with larger sample sizes are necessary to validate the use of c-IMT as a standard screening modality and to establish age- and sex-specific normative values.

## ETHICS

**Ethics Committee Approval:** The study protocol was approved by the University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (approval no: 2018-12-13, date: 25.06.2018).

**Informed Consent:** Informed consent for participation and publication was obtained from the parents or legal guardians of all participants.

## FOOTNOTES

### Authorship Contributions

Surgical and Medical Practices: B.A., S.S.H., Concept: B.A., F.P., E.D.P.Ç., E.Ş., Design: M.E.M., E.Ş., Data Collection or Processing: M.E.M., F.P., Analysis or Interpretation: B.M., E.Ş., Literature Search: B.M., Writing: M.E.M.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declare that this study received no financial support.

## REFERENCES

1. Özilbey P, Ergör G. Determining the prevalence of obesity in primary school students and eating habits in İzmir. *Tur J Public Health*. 2015;13:30-9.
2. Skinner AC, Perrin EM, Moss LA, Skelton JA. Cardiometabolic risks and severity of obesity in children and young adults. *N Engl J Med*. 2015;373:1307-17.
3. World Health Organization. Consideration of the evidence on childhood obesity for the Commission on Ending Childhood Obesity: report of the ad-hoc working group on science and evidence [Internet]. Geneva: WHO; 2016. Available from: <https://iris.who.int/handle/10665/206549>
4. Meyer AA, Kundt G, Steiner M, Schuff-Werner P, Kienast W. Impaired flow-mediated vasodilation, carotid artery intima-media thickening, and elevated endothelial plasma markers in obese children: the impact of cardiovascular risk factors. *Pediatrics*. 2006;117:1560-7.
5. Bots ML, Grobbee DE. Intima media thickness as a surrogate marker for generalised atherosclerosis. *Cardiovasc Drugs Ther*. 2002;16:341-51.
6. Mendes E, Mendes B, Karacabey K. Obesity and exercise during adolescence. *International Journal of Human Sciences [Internet]*. 2011;8:963-77. Turkish.
7. Barsh GS, Farooqi IS, O'Rahilly S. Genetics of body-weight regulation. *Nature*. 2000;404:644-51.
8. Poskitt E, Edmunds L. Management of childhood obesity. Cambridge: Cambridge University Press; 2008. Available from: <https://www.cambridge.org/core/books/management-of-childhood-obesity/A88F1A12056A64D292AD2CC2F9E76222>.
9. Dündar Y, Evliyaoğlu O, Hatun Ş. Short stature and obesity in school children: a neglected problem. *Türkiye Klinikleri J Pediatr*. 2000;9:19-22.
10. Klish WJ, Kirkland J, Motil K. Comorbidities and complications of obesity in children and adolescents [Internet]. Waltham (MA): UpToDate; 2015 [cited 2026 May 18]. Available from: <https://www.uptodate.com/contents/comorbidities-and-complications-of-obesity-in-children-and-adolescents>
11. Van Gaal LF, Mertens IL, De Block CE. Mechanisms linking obesity with cardiovascular disease. *Nature*. 2006;444:875-80.
12. Bots ML, Sutton-Tyrrell K. Lessons from the past and promises for the future for carotid intima-media thickness. *J Am Coll Cardiol*. 2012;60:1599-604.

13. Tamura H, Suzue T, Jitsunari F, Hirao T. Evaluation of carotid arterial intima-media thickness (IMT) and its relation to clinical parameters in Japanese children. *Acta Med Okayama*. 2011;65:21-5.
14. Koçyiğit A, Doğan M, Yılmaz İ, Çağlar M, Hatipoğlu C, Koçyiğit F, et al. Relation of age and sex with carotid intima media thickness in healthy children. *Turk J Med Sci*. 2014;44:422-6.
15. Şimşek F, Ulukol B, Berberoğlu M, Başkan Gülnar S, Adıyaman P, Öcal G. Obesity prevalence in a primary school and a high school in Ankara. *Ankara Üniversitesi Tıp Fakültesi Mecmuası*. 2005;58:163-6. Turkish.
16. Gürel FS, İnan G. Childhood obesity-diagnostic methods, prevalence and etiology. *Meandros Med Dent J*. 2001;2:39-46.
17. Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH. Long-term morbidity and mortality of overweight adolescents. A follow-up of the Harvard growth study of 1922 to 1935. *N Engl J Med*. 1992;327:1350-5.
18. Zanchetti A, Crepaldi G, Bond MG, Gallus GV, Veglia F, Ventura A, et al. Systolic and pulse blood pressures (but not diastolic blood pressure and serum cholesterol) are associated with alterations in carotid intima-media thickness in the moderately hypercholesterolaemic hypertensive patients of the plaque hypertension lipid lowering Italian study. PHYLLIS study group. *J Hypertens*. 2001;19:79-88.
19. Berenson GS, Srinivasan SR, Bao W, Newman WP 3rd, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa heart study. *N Engl J Med*. 1998;338:1650-6.
20. Koklu E, Kurtoglu S, Akcakus M, Koklu S, Buyukkayhan D, Gumus H, et al. Increased aortic intima-media thickness is related to lipid profile in newborns with intrauterine growth restriction. *Horm Res*. 2006;65:269-75.
21. Hatun Ş, Çizmecioğlu F. Obesity and insulin resistance syndrome in children (metabolic syndrome). *Turk Klin J Pediatr Sci*. 2006;2:40-6.