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Ultrasound Imaging of Carotid Intima Media Thickness and Related Risk Factors in the Central Black Sea Region: A field study

Orta Karadeniz Bölgesinde Karotis İntima Media Kalınlığının ve İlgili Risk Faktörlerinin Ultrason Görüntülemeyle İncelenmesi: Bir Saha Çalışması

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Abstract

Aim: Cardiovascular diseases (CVD) are a leading cause of global mortality, often associated with atherosclerosis. Carotid intima-media thickness (CIMT) is a validated, non-invasive ultrasonographic marker for the early diagnosis and monitoring of subclinical atherosclerosis. The aim of this study is to determine the frequency of atherosclerosis and related pathologies in the residents of Tokat city in the central Black Sea region using CIMT measurement on ultrasound.

Material and Method: The study was conducted as a prospective field study. Carotid ultrasound examinations were performed on 822 participants living in Tokat province between September 2012 and July 2013. Data regarding demographics, lifestyle habits (smoking, alcohol, diet, exercise), and medical history were collected via questionnaires. Additionally, participants underwent physical examinations and laboratory analyses, including lipid profiles, fasting blood glucose, and HbA1c levels.

Results: The average age of the participants was 47.2 years (45.2% male, 54.8% female). Increased CIMT was significantly associated with advanced age and male gender (p=0.001). Statistical analysis revealed that higher CIMT values correlated significantly with high LDL-C, high triglycerides, low HDL-C, smoking and elevated Body Mass Index (BMI) Furthermore, participants with hypertension and diabetes mellitus showed significantly higher CIMT values compared to those without these conditions .No significant relationship was found between CIMT and alcohol consumption or dietary characteristics.

Conclusion: Advanced age, male gender, dyslipidemia, smoking, obesity, hypertension, and diabetes are major risk factors for increased CIMT in this population. Ultrasonographic measurement of CIMT remains an effective, non-invasive, and easily applicable method for the early detection and monitoring of subclinical atherosclerosis in asymptomatic individuals at risk.

Keywords: Atherosclerosis, carotid intima-media thickness, ultrasonography

Öz

Amaç: Kardiyovasküler hastalıklar (KVH), dünya çapında en yaygın ölüm nedenlerinden biridir ve damar duvarında kalınlaşmaya neden olan ateroskleroz ile ilişkilidir. Karotis intima-media kalınlığı (KİMK), subklinik aterosklerozun erken teşhisi ve takibi için doğrulanmış, non-invaziv bir ultrasonografik belirteçtir. Bu çalışma, Tokat ilinde yaşayan bireylerde KİMK ölçümü yaparak ateroskleroz sıklığını belirlemeyi ve ilişkili risk faktörlerini tanımlamayı amaçlamaktadır.

Gereç ve Yöntem: Bu prospektif alan çalışmasına, aile hekimi takibinde olan ve gönüllü olan 20 yaş ve üzeri, rastgele seçilmiş 822 katılımcı dahil edilmiştir. Karotis ultrason muayeneleri, 5 MHz lineer prob kullanılarak yapılmış ve KİMK ölçümleri ana karotis arterin arka duvarından alınmıştır. Katılımcıların demografik bilgileri, yaşam tarzı alışkanlıkları (sigara, alkol, diyet, egzersiz) ve tıbbi geçmişlerine dair veriler anketler yoluyla toplanmıştır. Ayrıca katılımcılara fiziksel muayene yapılmış ve lipid profili, açlık kan şekeri ile HbA1c seviyelerini içeren laboratuvar analizleri için kan örnekleri alınmıştır.

Bulgular: Katılımcıların yaş ortalaması 47,2'dir (%45,2 erkek, %54,8 kadın). Artmış KİMK değerleri, ilerleyen yaş ve erkek cinsiyet ile anlamlı derecede ilişkili bulunmuştur . İstatistiksel analizler, yüksek KİMK değerlerinin yüksek LDL-K, yüksek trigliserit, düşük HDL-K, sigara kullanımı ve artmış Vücut Kitle İndeksi (VKİ) ile anlamlı korelasyon gösterdiğini ortaya koymuştur. Ayrıca, hipertansiyon ve diyabet tanısı olan katılımcıların KİMK değerleri, bu hastalıkları olmayanlara göre anlamlı derecede yüksek çıkmıştır . Alkol tüketimi veya diyet özellikleri ile KİMK arasında anlamlı bir ilişki saptanmamıştır.

Sonuç: İleri yaş, erkek cinsiyet, dislipidemi, sigara kullanımı, obezite, hipertansiyon ve diyabet, bu popülasyonda artmış KİMK için temel risk faktörleridir. KİMK'nin ultrasonografik ölçümü, risk altındaki asemptomatik bireylerde subklinik aterosklerozun erken teşhisi ve takibi için etkili, non-invaziv ve kolay uygulanabilir bir yöntem olmaya devam etmektedir.

Anahtar Kelimeler: Ateroskleroz, karotis intima-media kalınlığı, ultrasonografi

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INTRODUCTION

Cardiovascular diseases (CVD) are among the most common causes of death worldwide. CVD is associated with atherosclerosis, which causes thickening of the blood vessel walls. One of the parameters used to evaluate atherosclerosis is intima-media thickness (IMT). Many publications have shown a relationship between IMT and cerebral infarction and cardiac infarction.[1,2] Ultrasonography (USG) is the most suitable imaging method for measuring IMT due to its non-invasive nature, lack of radiation, ease of application, and repeatability. The common carotid artery (CCA) can be easily evaluated with USG, and IMT measurement can be performed on this structure. Therefore, IMT measurement is routinely performed from the CCA.[3] Thus, CCA IMT(CIMT) is used in the early diagnosis and follow-up of patients without clinical findings but at risk of CVD, and in the follow-up of patients treated for CVD.[4,5] The aim of this study is to determine the frequency of atherosclerosis and related pathologies in the residents of Tokat city in the central Black Sea region using CIMT measurement on ultrasound.

MATERIAL AND METHOD

Study Population

The study was conducted as a prospective field study. Carotid ultrasound examinations were performed on 822 participants living in Tokat province between September 2012 and July 2013. Participants were randomly selected from individuals over 20 years of age who were under family physician follow-up and volunteered to participate in the study. Each sample group was designed based on the Turkish Statistical Institute data reflecting the population pyramid of the region (gender, age group, etc.). The study was conducted in accordance with the Guidelines of the Declaration of Helsinki and its recommendations of Good Clinical Practice. This prospective study was approved by the institutional review board of Tokat Gaziosmanpaşa University (26-MOBAEK-233) in March 2012.

Questionnaire

Participants' age and gender were recorded. They were asked about smoking and alcohol use, frequency of red meat consumption, medication use, and their preferred type of fat in their diet (sunflower oil, butter, margarine, olive oil). Their history of chronic diseases such as hypertension and diabetes mellitus was also recorded. Whether they regularly engaged in sports or exercise was also asked and recorded in the survey.

Physical Examination

Participants' height, weight, and blood pressure were measured and recorded. Their BMI (body mass index ,weight/height squared) was calculated. With their consent, blood samples were taken from participants to analyze lipid profile, fasting blood glucose, HbA1c, and other parameters.

US Imaging

US examination was performed on all participants by two radiologists with at least 10 years of experience using a Toshiba Aplio 500 2012 brand US device with a 5 MHz linear probe. Participants were examined in a supine position with their heads hyperextended and turned to the opposite side. First, the CCA was scanned axially along its length up to the bifurcation level. Then, the probe was placed longitudinally to image the CCA in the sagittal plane, and the CIMT was measured from the plaque-free posterior wall. Sagittal imaging of the CCA must be used, and at least five measurements must be taken on each side to obtain an average value ("average CIMT").

Measurement was done on the posterior wall of the CCA on the right and left side, 1 cm inferior from the carotid bifurcation. CIMT is considered as the distance between two hyperechoic lines in the carotid wall (**Figure 1**). These hyperechoic lines represent the lumen-intima interface and the media-adventitia interface.[6] Participants were divided into three groups: those with intima thickness less than 0.5 mm, those with 0.5-0.7 mm, and those with 0.7-1 mm. An CIMT value of 1 mm or higher was considered as plaque.[7]

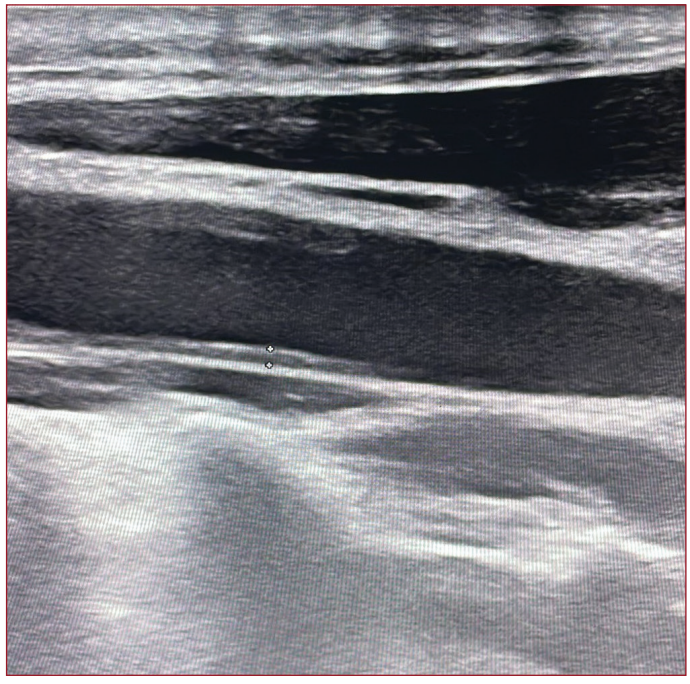

Figure 1. US measurement of Carotid intima media thhickness

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 22.0 (IBM Corp., Chicago, IL, USA). Descriptive statistics were expressed as mean±standard deviation (SD) for continuous variables and as number (n) and percentage (%) for categorical variables. Associations between categorical variables were evaluated using the Pearson chi-square test. A p-value of<0.05 was considered statistically significant.

RESULTS

Participant Characteristics

The ages of the 822 participants whose carotid arteries were examined ranged from 20 to 87, with an average age of 47.2. Regarding gender distribution, 45.2% (n=372) were male and 54.8% (n=450) were female. Quantitative and qualitative variables distribution in the total study group is presented in **Tables 1** and **2**.

Table 1. Distribution of Quantitative Variables in the Total Study Group

Variables	Mean+SD	Minimum	Maximum
Age	47.24±15.36	20	87
Glucose	98.52±39.35	0.8	558.5
HDL-C	50.34±13.72	7.9	139.2
LDL-C	124.26±35.76	31.6	317.3
TG-C	134.28±88.65	25	1244.2
BMI	28.94±5.63	16.04	55.53
R-CIMT	0.61±0.21	0.1	1.8
L-CIMT	0.63±0.35	0.1	8

LDL-C (low-density lipoprotein cholesterol), TG (triglyceride), HDL-C (high-density lipoprotein cholesterol), BMI (body mass index), R CIMT (right carotid intima-media thickness), L CIMT (left carotid intima-media thickness)

US Outcomes

Right CIMT was 0-0.5 mm in 43.7% of participants, 0.5-0.7 mm in 34.4%, and 0.7-1 mm in 21.9%. Left CIMT was 37.4%, 40.3%, and 22.3%, respectively. 92.1% of participants had no plaque. Of those with plaque, the plaque type was calcified in 16.7%, fibrofatty in 81.5%, and mixed in 1.9%.

Risk Factors for CIMT Increase

When the relationship between CIMT and other variables was examined (**Table 3**, **Table 4**) CIMT increased with age. When the relationship between CIMT and gender was examined, the proportion of female participants was higher in those with CIMT values in the 0-0.5 and 0.5-0.7 ranges (55.6%, 56.1%), while the proportion of male participants was statistically significantly higher in those with CIMT values in the 0.7-1 mm range (61.2%), (p:0.001).

In terms of laboratory parameters, CIMT significantly increased as low-density lipoprotein cholesterol (LDL-C) and triglyceride (TG) levels decreased, while high- density lipoprotein cholesterol (HDL-C) levels decreased. Significantly, persistent correlations were found between CIMT and blood glucose and HbA1c levels for both right and left CIMT (p<0.001). The proportion of individuals with high fasting blood glucose levels and high HbA1c levels increased with higher CIMT values.

61.3% of participants had a normal body mass index (BMI), while 38.7% had a BMI above 30. When examining the relationship between BMI and CIMT, CIMT increased as BMI increased (p<0.001). As CIMT increased, the number of participants with plaque increased.

Table 2. Distribution of Categorical Variables

	(%)
HT diagnosis	
Yes	(22)
No	(78)
DM diagnosis	
Yes	(11)
No	(89)
Smoking	
Never smoke	(62.1)
Still smoking	(20.3)
Smoked and quit	(17.6)
Alcol using	
Never	(90.2)
Yes	(2.2)
Rarely	(7.6)
Exercise habit	
Regular	(14.8)
Sometimes	(38.8)
Never	(46.4)
Frequency of eating red meat	
Every day	(7.8)
Every two or three days	(19.4)
Once a week	(35.4)
Rarely	(37.5)
Butter consumption	
Never	(15.4)
Rarely	(13.5)
Sometimes	(28.3)
Often	(18.8)
Always	(24.1)
Sunflower oil consumption	
Never	(7.9)
Rarely	(4.3)
Sometimes	(13.9)
Often	(21.5)
Always	(52.4)
Olive oil consumption	
Never	(24.4)
Rarely	(14.4)
Sometimes	(27.2)
Often	(15.1)
Always	(18.8)
Margarine consumption	
Never	(35.1)
Rarely	(20.2)
Sometimes	(24.1)
Often	(9)
Always	(11.6)
Diastolik blood pressure	
Normal	(75.3)
High	(24.7)
Cistolic blood pressure	
Normal	(73.1)
High	(26.9)
BMI	
Normal	(61.3)
Obes (BMI>= 30)	(38.7)
Fasting glucose level	
Normal	(74.8)
Impaired fasting glucose	(15.6)
Diabetes mellitus?	(9.6)
Hba1c level	
Normal	(80.2)
High	(19.8)

HT (hypertension), DM(Diabetes Mellitus), BMI (body mass index)

Table 3. Relationship R-CIMT and variables

Variables	R CIMT 0-0.5 (%)	R CIMT 0.5-0.7 (%)	R CIMT 0.7-1 (%)	p
Gender				0.001
Female	(55.6)	(56.1)	(38.8)	
Male	(44.4)	(43.9)	(61.2)	
Smoking				0.002
Never smoke	(56.3)	(62.7)	(49)	
Still smoking	(29.2)	(19.7)	(23.5)	
Smoked and quit	(14.6)	(17.5)	(27.5)	
Alcol using				0.524
Never	(88.3)	(91)	(89.8)	
Yes	(2.7)	(1.7)	(4.1)	
Rarely	(9)	(7.3)	(6.1)	
Exercise habit				0.234
Regular	(15.3)	(13.2)	(13.4)	
Sometimes	(45.7)	(37.7)	(41.6)	
Never	(39)	(49.1)	(45)	
Frequency of eating red meat				0.72
Every day	(6.9)	(7.6)	(7.4)	
Every two or three days	(24.1)	(22.2)	(22.1)	
Once a week	(34.7)	(28.9)	(34.9)	
Rarely	(34.4)	(41.3)	(35.6)	
HT diagnosis				<0.001
Yes	(11.3)	(23.5)	(39.9)	
No	(88.7)	(76.5)	(60.1)	
Butter consumption				0.598
Never	(8.2)	(9)	(6)	
Rarely	(12.8)	(17.6)	(17.9)	
Sometimes	(31)	(23.5)	(25.4)	
Often	(23.5)	(25.3)	(25.4)	
Always	(24.6)	(24.4)	(25.4)	
Sunflower oil consumption				0.874
Never	(8.7)	(8.1)	(6.8)	
Rarely	(4.3)	(7.7)	(7.6)	
Sometimes	(16.2)	(14.5)	(13.6)	
Often	(23.1)	(24)	(24.2)	
Always	(47.7)	(45.7)	(47.7)	
Olive oil consumption				0.69
Never	(16.9)	(17.8)	(15.3)	
Rarely	(18.7)	(13.9)	(16)	
Sometimes	(28.4)	(30.8)	(31.3)	
Often	(14)	(19.2)	(14.5)	
Always	(21.9)	(18.3)	(22.9)	
Margarine consumption				0.247
Never	(28.1)	(25.2)	(36.6)	
Rarely	(23.2)	(24.8)	(22)	
Sometimes	(25.5)	(26.2)	(26)	
Often	(8.4)	(11.9)	(8.9)	
Always	(14.8)	(11.9)	(6.5)	
BMI				<0.001
Normal	(74.7)	(53.2)	(43.3)	
Obes (BMI>= 30)	(25.3)	(46.8)	(56.7)	
Fasting glucose level				<0.001
Normal	(91.3)	(79.3)	(61.4)	
Impaired fasting glucose	(4.7)	(10.8)	(17.9)	
Diabetes mellitus?	(4)	(9.9)	(20.7)	

HT (hypertension), BMI (body mass index), R-CIMT (Right carotid intima-media thickness)

Tablo 4. Relationship L-CIMT and variables

Variables	L CIMT 0-0.5 (%)	L CIMT 0.5-0.7 (%)	L CIMT 0.7-1 (%)	p
Gender				0.273
Female	(54.2)	(53.2)	(46.5)	
Male	(45.8)	(46.8)	(53.5)	
Smoking				0.001
Never smoke	(58.9)	(58.7)	(50)	
Still smoking	(29.2)	(21.6)	(22.7)	
Alcol using				0.044
Smoked and quit	(11.9)	(19.7)	(27.3)	
Never	(86.8)	(90.6)	(92.6)	
Yes	(3.5)	(1.1)	(4.1)	
Rarely	(9.7)	(8.3)	(3.4)	
Exercise habit				0.263
Regular	(17.2)	(11.4)	(14.1)	
Sometimes	(41.8)	(40.8)	(45)	
Never	(41)	(47.8)	(40.9)	
Frequency of eating red meat				0.811
Every day	(6.8)	(7.1)	(8.1)	
Every two or three days	(23.2)	(22.5)	(23.6)	
Once a week	(34.4)	(30)	(35.1)	
Rarely	(35.6)	(40.4)	(33.1)	
HT diagnosis				<0.001
Yes	(9.2)	(21.7)	(43)	
No	(90.8)	(78.3)	(57)	
Butter consumption				0.092
Never	(11.3)	(6.9)	(4.3)	
Rarely	(11.7)	(18.1)	(17.4)	
Sometimes	(30.1)	(26.6)	(23.2)	
Often	(22.2)	(25.9)	(26.1)	
Always	(24.7)	(22.4)	(29)	
Sunflower oil consumption				0.785
Never	(9.3)	(7.3)	(7.4)	
Rarely	(4.2)	(7.7)	(6.7)	
Sometimes	(16.5)	(13.1)	(16.3)	
Often	(24.6)	(23.6)	(22.2)	
Always	(45.3)	(48.3)	(47.4)	
Olive oil consumption				0.455
Never	(17.9)	(16.4)	(15.8)	
Rarely	(20.1)	(14)	(15)	
Sometimes	(27.4)	(31.2)	(31.6)	
Often	(12.8)	(19.2)	(15)	
Margarine consumption				0.383
Always	(21.8)	(19.2)	(22.6)	
Never	(28.8)	(28.4)	(29.9)	
Rarely	(21.7)	(24.3)	(25.2)	
Sometimes	(27)	(22.6)	(29.9)	
Often	(8.8)	(12.8)	(5.5)	
Always	(13.7)	(11.9)	(9.4)	
BMI				<0.001
Normal	(77.7)	(55)	(41.2)	
Obes (BMI>= 30)	(22.3)	(45)	(58.8)	
Fasting glucose level				<0.001
Normal	(91)	(80.5)	(63.1)	
Impaired fasting glucose	(5.1)	(9.9)	(17)	
Diabetes mellitus?	(3.8)	(9.5)	(19.9)	

HT (hypertension), BMI (body mass index), L-CIMT (Left carotid intima-media thickness)

Regarding the relationship between CIMT and smoking, in the CIMT 0-0.5 group, 56.3% of participants were never smokers, while 43.7% were current smokers or former smokers. In the CIMT 0.5-0.7 group, these percentages were 62.7% and 34.3%, respectively, while in the CIMT 0.7-1 mm group, these percentages increased statistically significantly in favor of smokers, reaching 49% and 51% respectively (p: 0.002). No statistically significant relationship was found between alcohol use and CIMT (p: 0.524).

25.6% of participants had a diagnosis of (HT). The percentage of participants with HT was 11.3% in the CIMT 0-0.5 group, 23.5% in the CIMT 0.5-0.7 group, and 39.9% in the CIMT 0.7-1 group, showing a statistically significant relationship (p<0.001). When comparing the blood pressure measured during screening with CIMT, the percentage of individuals with high blood pressure was significantly lower in the CIMT 0-0.5 group (13.5%), while it increased statistically significantly in the CIMT 0.5-0.7 group (29.8%) and the CIMT 0.7-1 group (36.2%), respectively (p<0.001). Regarding the relationship between daily dietary characteristics and CIMT, no association was found between the use of butter, margarine, olive oil, or sunflower oil and CIMT. No correlation was found between frequency of red meat consumption and CIMT(p: 0.720).

DISCUSSION

Atherosclerosis is a systemic pathology that impairs the structure and function of vital organs in the body, such as the heart and brain. İncreased CIMT is an indication of early subclinical atherosclerosis and a risk factor for cardiovascular disease. Many studies have shown that increased CIMT is associated with an increased risk of myocardial infarction and stroke in elderly patients, even in the absence of a history of cardiovascular disease.[8,9] Measurement of CIMT by ultrasound is a method used to detect and monitor the presence of subclinical atherosclerosis in asymptomatic individuals.[10] Atherosclerosis is associated with many factors, including lipid metabolic diseases, age, and gender.[11]

The effect of hyperlipidemia on the formation of atherosclerosis has been explained as follows: Increased lipids can lead to increased vascular permeability and, secondary to this, damage to vascular endothelial cells. After damage, lipoproteins migrate into the intima, resulting in a macrophage response and proliferation of vascular smooth muscle cells.[12] Another role of hyperlipidemia in atherosclerosis is that it causes lipidosis in the arterial wall and disrupts the function of the blood coagulation-fibrinolysis system, creating a predisposition to thrombosis.[13] A study conducted on the local population of Shanghai found a correlation between increased total colesterol (TC), TG, LDL-C and increased CIMT.[12] Similarly, in our study, high LDL-C and TG values were statistically significantly associated with increased CIMT values. HDL-C, on the other hand, is a cardiovascular protective lipoprotein. However, it has been noted that cardiovascular risk is increased in hyperalphalipoproteinemia, a condition characterized by high HDL-C.[14] In our study, CIMT increased as HDL-C decreased. Similarly, we found higher CIMT values in obese participants with BMI above 30, consistent with the literature.[15] In particular, abdominal obesity has been shown to be associated with CIMT even in childhood.[16]

Age and gender are among the most important unmodifiable factors in the development of atherosclerosis. The development of carotid atherosclerosis increases with age) Therefore, there are studies showing that CIMT increases with age.[17] In line with the literature, our study also found a positive correlation between age and CIMT. A review of 90 articles published in 2024 examined the relationship between CIMT and age and gender. It stated that CIMT increased with age in both sexes, but this increase was postponed (10 years delayed) in women compared to men. It was reported that men had higher CIMT values compared to women, regardless of age. However, there are also publications showing no relationship between gender and CIMT.[18] In our study, however, there was a statistically significant relationship between male gender and high CIMT.

While some studies in the literature argue for a relationship between smoking and CIMT, others argue against it.[18-20] A study by Mitra et al. in 2025 on a large group emphasized that the effect of smoking on CIMT was much more significant than daily diet, alcohol intake, or sleep patterns.[9] In our study, CIMT was statistically significantly higher in smokers. There was no relationship between daily diet (red meat, alcohol consumption, type of fat used, etc.) and exercise and CIMT. A study investigating the relationship between smoking and atherosclerosis indicated an increase in serum high-sensitivity C-reactive protein (hsCRP), an acute phase reactant, and subclinical vascular damage immediately after smoking.[21]

When considering the relationship between chronic diseases and atherosclerosis, hypertension (HT) is known to be one of the leading diseases predisposing to atherosclerosis. Many studies have reported that the most significant effect of HT is on CIMT.[7,19,22] However, there are also studies that state that HT does not increase CIMT.[23] In this study, however, a relationship was found between increased CIMT and both those diagnosed with HT and those without a diagnosis but with elevated blood pressure measurements during screening.

Another important chronic disease associated with atherosclerosis is diabetes mellitus (DM). It is a common disease both worldwide and in our country. While many studies in the literature support a relationship between CIMT and DM[24,25] there are also publications showing no relationship.[26] This situation is attributed to the diagnosis of DM and good glycemic control with effective treatment. When HbA1c improves, myocard infarction (MI) and DM-related microvascular complications also decrease.[24] Kayastha et al. showed that CIMT values were higher in DM patients in their study on CIMT measurement (CIMT DM). Furthermore, in this study, they found higher CIMT values in female DM patients compared to male DM patients. In our study, a statistically significant relationship was found between CIMT and both those diagnosed with DM and those with high fasting blood glucose and HbA1c levels in laboratory results.

This study has several limitations. Although it is a field study, only participants from the city center were included because ultrasound equipment could not be transported to rural areas. More objective data could be obtained with larger studies including participants from both rural and urban areas and from different cities. Since some parameters such as daily dietary habits, exercise, and smoking/alcohol use were marked on the questionnaire according to the participants' answers, long-term follow-up of this information could not be carried out in our study, and participants' statements were taken as the basis. This is another limitation of our study. However, the prospective and field study nature of our study, and the fact that the participants were randomly selected rather than from a specific group, provides a high degree of reliability in terms of evaluating parameters that may be related to CIMT and constitutes its strengths.

CONCLUSION

Male gender and advanced age are important and unmodifiable criteria for CIMT. High TG and LDL-C levels, low HDL-C levels, and smoking are modifiable risk factors. Daily diet does not affect CIMT thickness, while CIMT increases in chronic diseases such as DM and HT. In individuals with modifiable or unmodifiable risk factors, ultrasound, a non-invasive and easily applicable method, can be used to demonstrate and monitor the presence of increased CIMT, which is an indicator of subclinical atherosclerosis.

ETHICAL DECLARATIONS

Ethics Committee Approval: Ethical approval for the study was obtained from the Tokat Gaziosmanpaşa University Clinical Research Ethics Committee (Decision No: 26-MOBAEK-233).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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