Cardiology in the Young

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The effect of smartphone addiction on vessel wall thickness, which is a predictor of atherosclerosis

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Original Article

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Abstract

Aim: The increasing global popularity of smartphone usage has increased concerns about the negative effects of smartphone addiction, such as lack of sleep, sedentary life, bad eating habits, anxiety, stress, and depression, especially among the young population. These problems caused by smartphone addiction are also well-known risk factors for atherosclerosis. However, according to our observation, there is no research in the literature that directly shows the relationship between smartphone addiction and subclinical atherosclerosis. In this study, carotid intima-media thickness, an important surrogate marker in demonstrating subclinical atherosclerosis, was used to examine the relationship between smartphone addiction and subclinical atherosclerosis. *Materials and method:* This cross-sectional study was conducted on 96 high school students aged between 13 and 22 years. A smartphone addiction questionnaire consisting of 33 questions was applied to measure smartphone addiction. Along with the socio-demographic characteristics of the patients, factors such as eating habits, sleep patterns, and activity levels were also questioned. The mean carotid intima-media thickness was measured by an experienced sonographer according to the published and accepted methods. *Results:* When we set the threshold for smartphone addiction at over 66 points, we discovered that the group with smartphone addiction had considerably thicker carotid intima-media (0.68 ± 0.2 versus 0.45 ± 0.1; $p < 0.001$). In addition, logistics regression analysis had shown that smartphone addiction level independently affects the carotid intima-media thickness (odds ratio:1.111; %95 GA:1.057–1.168, $p < 0.001$). *Conclusion:* Smartphone addiction may help prediction of subclinical atherosclerosis via carotid intima-media thickness among teenagers.

Today's internet is a global network with more accessible service locations, so its' use increases across all age groups. Although technology is recognised as a positive phenomenon, technology addiction increases users' perception that the system is beneficial, which results in its excessive use in an unhealthy manner. Recent developments in mobile and wearable technologies enable internet connection wherever and whenever we want, which causes increase in internet addiction.[1]

Smartphones are one of the easiest way to access the internet. With the ever-increasing number of their users worldwide, smartphones are technological devices that can process more data than other phones and have many properties, such as navigation, internet access, and multimedia.[2,3] This causes many problems due to its increasing popularity and excessive use.[2] It may be defined as smartphone addiction when a person does not want to be far from her/his own phone but engages in the phone in such a way as to delay things to do in her/his daily life and experiences withdrawal when she/he is far from it. Although having a smartphone is beneficial according to the students, it is a known fact that there is a strong association between some psychiatric disorders and smartphone addiction. These include depression, anxiety, bipolar disorder, dependent personality disorder, compulsive personality disorder, and somatisation.[4–7] Several studies have highlighted that cell-phone addiction is associated with worse sleep quality.[8,9] Again, cell-phone addiction was related to lack of practice in physical activity, eating disorders, and rise in anthropometric measurements.[10,11] The above-mentioned smartphone addiction-related factors are also well-known risk factors for atherosclerosis. Atherosclerosis starts during childhood and leads to cardiovascular diseases in adulthood. Thus, early precursors of vascular changes – subclinical atherosclerosis – warrant special attention as this process can be stabilised or even reversed if treated in time.[12] Sonographic Intima Media Thickness measurement of the carotid artery (carotid intima-media thickness) is considered a valid surrogate marker for cardiovascular risk allowing assessment of atherosclerotic changes at a very early stage.[13]

Although many studies revealed that smartphone addiction is associated with known risk factors for atherosclerosis,[4–11] no study has been found in the literature that directly addresses the relationship between smartphone addiction and subclinical atherosclerosis. In only one study, Zou et al. investigated and confirmed that smartphone addiction is associated with hypertension in Chinese adolescents.[14] As there is no information available in this area, it is

crucial to provide evidence for the various stakeholders to make a conscious determination on appropriate public health interventions. Therefore, this research was planned and conducted to show the relationship between smartphone addiction and subclinical atherosclerosis.

Materials and method

Study population

This cross-sectional study, carried out between October 2022 and April 2023, was conducted on 96 students aged 13–22, studying at a high school in Turkey. Forty-six of them are male and 50 of them are female. The sample of this study was randomly selected among high school students who were studying at Adapazarı ENKA Schools. After the study was explained to them, a written consent form was obtained from the students who volunteered. The primary inclusion criterion was being a smartphone user. Students with alcohol and substance abuse, pregnant, or lactating at the time of this study, and any chronic or acute disease, such as diabetes, kidney disease, cardiovascular diseases, cancer, and thyroid disease were excluded from this study. Students who regularly use any supplements or medications were also not included in the study. The body mass index (BMI) (kg/m^2) was calculated by dividing the body weight (in kilograms) by the square of height (in metres). A questionnaire form was used to determine the general characteristics of students' age, gender, department, housing status, and socio-economic status. In addition, questions about eating habits and smartphone use, such as the number of meals, reason for skipping a meal, years of using a smartphone, time spent on a smartphone daily, and purpose of using a smartphone were asked to the students. Mindful eating questionnaire and smartphone addiction scale were used to measure eating disorders and smartphone addiction, respectively. Sample size was determined to be 94 students by using the power analysis method (95% confidence interval, 5% error level, 0.35 effect size) and 96 students were included in this study.

Smartphone addiction scale

Smartphone addiction scale was improved by Known et al.[15] It was adapted to Turkish by Demirci et al.[3] and its internal consistency coefficient was found to be 0.947. The Cronbach's alpha reliability coefficient was found to be 0.951 in this study. The scale uses a 6-point Likert-type rating (1 = I strongly disagree, 6 = I strongly agree). The total score ranges from 33 to 198, and the smartphone addiction levels were ascertained based on the scores. According to scores, smartphone addiction was categorised into two groups: adolescents who scored less than 67 were categorised as the general user group for reference, and those with scores equal to or higher than 67 were the smartphone addicted group.[3,15]

Mindful eating questionnaire

Mindful eating questionnaire measures the behaviours and attitudes related to eating, and the symptoms of possible disorders in eating behaviours in normal individuals. The scale uses a 5-point Likert type rating (1: never, 2: rarely, 3: sometimes, 4: often, 5: always). The level of the total score is directly related to the level of psychopathology. Items 1, 7, 9, 11, 13, 15, 18, 24, 25, and 27 in mindful eating questionnaire are reverse scored. The cut-off point is 30 points. It was developed by Garner[16] and translated into Turkish by Erol[17] after a validity and reliability study. The internal consistency coefficient of the test was determined as 0.70 in Erol's study. The Cronbach's alpha reliability coefficient was found to be 0.79 in this study.

Measurement of carotid intima-media thickness

Carotid intima-media thickness of common carotid artery and internal carotid artery was measured by ultrasonography of the left and right carotid artery according to the previously determined methods.[12] Carotid intima-media thickness measurement was available for all patients.

Statistical analysis

The data were analysed by using the SPSS 23.0 package program. Continuous variables are expressed as mean ± standard deviation (x ± sd) and categorical variables as numbers and percentages. Comparisons between groups of students were performed using chi-square tests for categorical variables, independent-samples *t* test for normally distributed continuous variables, and Mann–Whitney U tests when the distribution was skewed. The relationship between the two groups in numerical data was tested with Pearson correlation analysis in the data showing normal distribution, and Spearman correlation analysis in those without normal distribution. A p value < 0.05 was considered statistically significant.

Results

The characteristics of participants, both overall and stratified by smartphone addiction scale score, are shown in Table 1. A total of 96 participants with an average age of 17.1 ± 1.6 years were included in the analysis, and 52.08% (n = 50) of them were female. At the time of enrolment, the mean±SD score for the smartphone addiction scale index was 92.69 ± 23.33. Those with smartphone addiction scale index score <67 and ≥67 accounted for 38.54% (n = 37) and 61.45% (n = 59) of participants, respectively. There was no statistically significant difference between the two groups regarding sex, age, BMI, and family structure. Although regular inactivity and difficulty in falling asleep were more common in smartphone addict group, the difference was not statistically significant. Daily sleeping hours were longer in general user group compared to smartphone addict group (p = 0.026). Mindful eating questionnaire scores were significantly higher in the smartphone addict group than the general user group (89.1 ± 14.1 and 78.9 ± 10.7, respectively). The mean carotid intima-media thickness was 0.62 ± 0.22 mm overall, and among groups with different smartphone addiction scale index scores, it was significantly higher in smartphone addict group (p = 0.001).

Partial correlation analyses showed that carotid intima-media thickness was positively correlated with smartphone addiction scale score (r = 0.719, p < 0.001) and mindful eating questionnaire scores (r = 0.511, p < 0.001) (Fig 1).

To identify factors associated with carotid intima-media thickness, we performed a multiple regression with carotid intima-media thickness adjusted for smartphone addiction scale and mindful eating questionnaire score only, and then we carried out a multivariable model including all relevant variables and carotid intima-media thickness. Our model predicted 33.9% variation in carotid intima-media thickness, with smartphone addiction scale score as the strongest correlate (β = 0.613; p < 0.001).

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Table 1. Demographic and clinical characteristics of the patients according to whether they have smartphone addiction or not.

	Total (n:96)	SAS<67 (n:37)	SAS≥67 (n:59)	p
Age (year) (average ± SD)	17.1 ± 1.6	16.9 ± 1.3	17.3 ± 1.7	0.876
Gender (female, %)	52.1	55.5	50.7	0.674
Time to use smartphone (h/day) (mean ± SD)	6.1 ± 2.9	5.0 ± 2.7	6.9 ± 2.9	0.001
Family structure (fragmented family, %)	14.6	11.1	15.9	0.543
Doing regular physical activity (yes, %)	32.3	44.4	24.6	0.057
Difficulty while falling asleep (yes,%)	35.4	22.2	40.5	0.072
Sleep time (hours/day)	6.8 ± 1.0	7.3 ± 1.2	6.1 ± 1.0	0.026
Body mass index (kg/m^2)	20.1 ± 2.9	20.1 ± 2.3	19.9 ± 3.1	0.567
Mindful eating questionnaire score (mean ± SD)	85.3 ± 14.1	78.9 ± 10.7	89.1 ± 14.1	0.002
Carotid intima-media thickness (mean ± SD)	0.62 ± 0.2	0.45 ± 0.1	0.68 ± 0.2	0.001

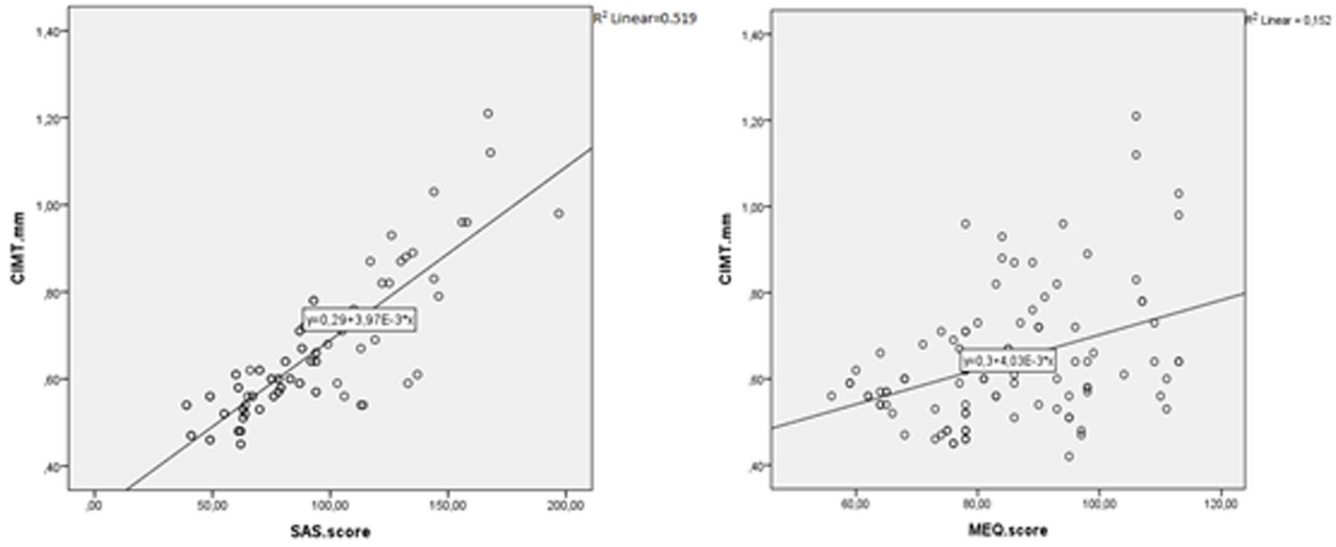

Figure 1. Correlations among carotid intima-media thickness (CIMT, mm) with smartphone addiction scale (SAS) score and mindful eating questionnaire (MEQ) score in all patients.

We investigated the association between smartphone addiction scale score and increased carotid intima-media thickness (≥0:6 mm) based on multiple logistic regressions. Smartphone addiction scale score was significantly associated with the risk of increased carotid intima-media thickness [1.111 (1.057–1.168), p < 0:001] after adjusting for confounding factors (Table 2).

Discussion

To the best of our knowledge, the present study is the first to evaluate the relationship between adolescents' smartphone addiction and the risk of atherosclerosis. Interestingly, we showed that smartphone addiction was significantly associated with carotid intima-media thickness.

There are about 13 million young people aged 15–24 in Turkey. This is 17.6% of the total population.[18] Young ages carry a risk of having bad habits, such as smartphone addiction. Previous research has demonstrated the adverse effects of smartphone addiction and overuse on some psychiatric and sleep disorders, dietary behaviour, and lifestyle in university/college/school students. The adverse outcomes identified in these research may also be atherosclerotic risk factors. Epidemiological studies showed that carotid intima-media thickness is a marker of subclinical atherosclerosis and is associated with conventional risk factors of cardiovascular diseases. Carotid intima-media thickness calculation is the most widely used non-invasive atherosclerosis assessment by clinicians and clinical investigators.[19]

This study indicated that 61.45% of students are potential smartphone addict and 41.68% are at risk of eating disorders. These rates are significantly higher than previous studies.[9,10,19–21] Although our study was conducted in a limited population and with a low number of cases, it is undeniable that smartphone addiction is increasing every year. It is necessary to clarify the rates of smartphone addiction in society with large-scale studies.

Smartphone addicts may not be aware of how much they eat because they are constantly busy with the internet. They can skip meals or eat unhealthy snacks as they are more practical. This unintentional behaviour may lead to eating problems and harm health in the future. And consequently, undesirable weight gains and psychological and social problems may occur. Although the

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Table 2. Results of logistic regression analysis for increased carotid intima-media thickness.

Variables	p	odds ratio	95% CI
Gender (female)	0.07	4.524	0.894–22.886
Body mass index (kg/m^2)	0.34	1.168	0.848–1.609
Fragmented family	0.04	0.112	0.013–0.966
Doing regular physical activity	0.17	1.663	0.288–9.592
Sleep time	0.02	0.341	0.138–0.845
Difficulty falling asleep	0.06	1.540	0.297–4.994
Mindful eating questionnaire score	0.04	1.048	1.001–1.110
Smartphone addiction scale score	<0.001	1.111	1.057–1.168

(CIMT≥0:6).

correlation between students' BMIs and smartphone addiction scale scores varies across studies, unhealthy eating habits were seen in all studies.[21–24] While no correlation was observed between smartphone addiction and BMI in our study, a significant relationship was observed between smartphone addiction scores and mindful eating questionnaire scores. The positive interrelation between smartphone overuse and sleep problems, neuropsychological disorders, and sedentary behaviours was demonstrated in our study in parallel with previous studies.[10,18–25]

Limitations

The current study has some limitations. Principally, we could only evaluate the relations, not the causal connection between variables. Second, our results were obtained in a high school in only one city of Turkey and consequently may not be generalised to other ethnic groups with different demographic characteristics. In addition, all patients in this study were between 13 and 22 years, and thus, the findings may not be generalised to other age groups.

Conclusion

In summary, our study shows that smartphone addiction was significantly associated with the risk of atherosclerosis development in Turkish adults. Future studies are necessary to confirm the relationship between smartphone addiction and subclinical arteriosclerosis and elucidate the potential mechanisms underlying this association.

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Competing interests. None.

Ethical standards. Written informed consent form was signed by the students who agreed to participate in the study and Ethical Committee Approval numbered 2022-13 and dated 03.10.2022 was obtained from Atlas University Ethics Committee.

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