Original Article

The Effects of Smoking Cessation on Visceral Adiposity Index Levels

S Pekgor, C Duran[1], K Marakoglu[2], I Solak, A Pekgor[3], MA Eryilmaz[4]

Department of Family Medicine, Konya Health Application and Research Center, University of Health Sciences, Konya, [1]The Medical School of Usak University, The Department of Internal Medicine, The Division of Endocrinology and Metabolism, Usak, [2]Department of Family Medicine, Selcuk Medical School of Selcuk University, [3]Department of Statistics, Ahmet Kelesoglu Faculty of Education, Necmettin Erbakan University, [4]Department of General Surgery, Family Medicine Clinic, Konya Health Application and Research Center, University of Health Sciences, Konya, Turkey

Abstract

Background: Known to cause important metabolic disturbances, weight gain becomes a major health problem after smoking cessation. Visceral adiposity index (VAI) is becoming increasingly popular in the detection of cardiometabolic risks in several disorders and general population. Here, we aimed to investigate the effects of quitting smoking on VAI levels. **Materials and Methods:** Of 350 participants included into the cigarette cessation program, 70 (20%) completed the study and were enrolled into the analyses. VAI levels were calculated at the baseline and 3rd month after cigarette cessation. **Results:** Thirty-eight (54.3%) out of 70 participants were male. While the mean age was found as 42 ± 1.0 years, mean starting age of smoking was found to be 16.87 ± 0.45 years, and mean smoking time was 23.07 ± 1.18 years. While VAI levels were found higher in men at the baseline, VAI levels were found similar in both genders at the end of the study. Higher VAI levels were found in those smoking >20 cigarettes/day, compared to those smoking ≤20 cigarettes/day. Although weight, waist circumference, body mass index (BMI), and high-density lipoprotein cholesterol levels increased, VAI levels were found to decrease significantly at the 3rd month. In subgroup analyses, VAI levels were seen to decrease significantly only in men ($P = 0.005$). Furthermore, VAI levels were found to decrease ($P < 0.001$) in those with BMI ≥25 kg/m^2, whereas no significant change was observed in those with BMI <25 kg/m^2. **Conclusions:** Although body weight increases significantly after quitting smoking, VAI levels, an indicator of cardiovascular risks, decrease significantly, especially in men or obese patients.

Keywords: *Obesity, quitting smoking, smoking cessation, visceral adiposity index, weight gain*

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Introduction

The direct results of smoking cigarettes and other tobacco products, such as cancers and cardiovascular disorders (CVD), and the indirect results, such as obesity, dyslipidemia, insulin resistance (IR), hypertension, and many other unknown effects, are among the most common preventable reasons of morbidity and mortality across the world.[1-3] Although cigarette smokers are known to have generally lower weight and body mass index (BMI) than nonsmokers, it has been reported that as an important reason of CVDs, abdominal obesity is encountered more commonly in cigarette smokers.[4-8] On the other hand, the cessation of smoking generally leads to weight gain,[9-13] and so weight gain is a notorious barrier for many smokers not to stop smoking.[14] Compared to overall obesity, abdominal obesity is known to be more associated with metabolic syndrome (MetS) and its components such as IR, type 2 diabetes mellitus, dyslipidemia, or hypertension and lead to CVDs at a higher rate.[15,16] In clinical practice, BMI is a commonly used and safer parameter to evaluate obesity, but there is no linear association between BMI and body fat percentage. In addition, such features as gender, race, hydration status, and body-muscle mass

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Address for correspondence: Prof. C Duran, The Department of Internal Medicine, The Division of Endocrinology and Metabolism, The Medical School of Usak University, Usak 64200, Turkey.
E-mail: drcduran@gmail.com

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are known to have various effects on BMI.[17] As a predictor of metabolic and CVDs, central obesity can be measured easily through waist circumference (WC) as a more reliable parameter. In the definition of MetS, WC has been replaced with BMI;[18,19] however, it should be kept in mind that the measurement of WC includes the volumes of both subcutaneous and visceral adipose tissues (VAT). Metabolic disturbances have a stronger association with VAT, compared to subcutaneous adipose tissue. Since VAT, but not subcutaneous, plays a significant role in the development of IR, CVDs, or other metabolic disturbances, the differentiation of true visceral adiposity from the central or abdominal type of obesity is of major importance.[20] For this reason, in the investigation of visceral adiposity, the International Diabetes Federation recommends that computerized tomography (CT) or magnetic resonance imaging (MRI) be used as significant screening devices.[21] As methods recommended to evaluate visceral fat tissue, CT, MRI, and dual-energy X-ray absorptiometry are yet to be utilized in routine clinical practice because of cost-effectiveness and radiation risks.[22,23] The visceral adiposity index (VAI) has been adopted and successfully used in the prediction of IR and cardiometabolic risk factors in different disorders and general population as an indicator of the functions of visceral adipose tissue.[24-27] VAI levels are calculated easily through a mathematical formula using anthropometric (BMI and WC) and biochemical (high-density lipoprotein [HDL] cholesterol and TG) parameters.[25] In a recent study, VAI was reported to show an excellent discriminatory ability in the diagnosis of MetS.[28] Cigarette smoking is known to have effects on all of the parameters used in the formula.[5,7,29,30] VAI levels, a predictor of CVDs, still remain uninvestigated in those kept on or quitting smoking; in other words, the effects of smoking cessation on VAI levels has not been evaluated. In the present study, we aimed to investigate the changes of VAI levels after smoking cessation as an indicator of true visceral obesity cardiometabolic risks.

Materials and Methods

This prospective study was conducted in 350 individuals between the ages of 18–65, willing to cease cigarette smoking and admitted to the Outpatient Clinics of Family Medicine Department of Konya Health Application and Research Center, University of Health Sciences, between March and July 2016. The study protocol was approved by the ethics committee of Selcuk University. All individuals were informed about the study design, and consent was obtained from those accepting to take part. The participants on drugs affecting IR, inflammation and lipids, such as estrogens, oral contraceptives, corticosteroids, immunosuppressants, antihyperlipidemics, antihypertensives, thiazide, antihyperglycemics, and insulin sensitizers in the past 6 months, or those with any known active infections, malabsorption, anorexia, inflammatory diseases, such as Crohn's disease, ulcerative colitis, rheumatoid arthritis, systemic lupus erythematosus or benign or malignant hematologic disorders, any solid tissue cancers, undergoing liposuction, exposed to any surgical intervention within the past 6 months, pregnancy and breastfeeding, on illegal drugs and alcohol, and continuing cigarette smoking after the study enrollment were excluded from the study.

Age, gender, height, weight, WC, BP, exercise status, starting age to smoke, number of cigarettes smoked per day, duration of smoking, and number and length of quitting attempts of smoking were recorded on study charts. The 6-item Fagerstrom's Nicotine Addiction Test (FNAT), scored between 0 and 10, was performed in all the participants.[31] In FNAT, those receiving scores between 0 and 4 are described as mild nicotine addictives, those with scores between 5 and 6 as moderate addictives, and those with scores between 7 and 10 as severe nicotine addictives. The validity and reliability of Turkish version of the test were conducted by Uysal *et al*.[32] in 2004, and the reliability was found at moderate level as $\alpha = 0.56$. Height (m) and weight (kg) were measured with underwear clothing. WC was measured as the minimum size between iliac crest and lateral costal margin. BMI was calculated as weight (kg)/height square (m^2). Carbon monoxide (CO) in expiration breath was measured with a carboxymeter device (Smokerlyzer, Bedfont Scientific Ltd. Washington D. C., USA). The test was performed by the same researcher SP, whereas the participants were in sitting position, taking deep breath for 15 s, and expiring slowly. The test results were presented as ppm. Blood samples of 5 cc were IV drawn from all participants to measure BP (TG) and HDL-cholesterol after 12-h fasting in the morning, and the samples were chilled, centrifuged, and stored at −80°C until the analyses of TG and HDL. All participants were supported and encouraged to cease smoking and treated with bupropion (Zyban®, GlaxoSmithKline, GB) as 150 mg twice per day. Except for routine daily exercise, the study population was recommended no advice on dietary and exercise during the study period, and the participants kept on their normal diet and exercise habitus.

All the participants were called at least 3 months after the first visit for quitting smoking attempt; however, 23 of 350 participants gave no response to telephone calls, and 126 (36%) were found out to quit smoking

and continue not to smoke, based on self-reporting. One hundred and twenty-six participants continuing not to smoke were invited to the department, but only 70 (20%) cases responded the invitations and complied with the follow-ups. Refusing to come to the controls because of such reasons as being out of the city, busy doing work, wishing withdrawal from the study and rejecting re-tests, 56 individuals were excluded out of the criteria. Anthropometric measurements and laboratory tests were repeated 3 months after the attempt of quitting smoking. Therefore, the study was completed with 70 participants.

The levels of HDL-cholesterol (NR, 40–90 mg/dL) were measured with immune reaction (antigen-antibody complex) using an Olympus AU 5800 device (Beckman Coulter Inc., CA, USA), and TG levels (NR, 0–200 mg/dL) were measured using a routine enzymatic method with an AutoAnalyzer, Olympus AU 5800 device (Beckman Coulter Inc., CA, USA). VAI levels were calculated for women and men by the formula, (WC/(36.58+ [1.89 × BMI)]) × (TG [mmol/L]/0.81) × [1.52/HDL-cholesterol (mmol/L)]) and (WC/[39.68+ (1.88 × BMI)]) × ([TG (mmol/L)/1.03] × [1.31/HDL-cholesterol (mmol/L)]), respectively.[25]

The statistical analyses of the data were carried out with SPSS version 21.0 (Chicago, USA) statistical software package. The normality of the data was analyzed with the Shapiro–Wilk test. The descriptive statistics for variables with normal distribution of continuous data (mean ± standard deviation) and with no normally distributed variables (median [minimum: Maximum]) were indicated. The variables compared at the baseline and 3rd month was calculated as percentile changes, based on baseline values. The Mann–Whitney U test, one of nonparametric tests, was used to compare two independent variables in different groups, whereas the Wilcoxon Signed-Rank test for two dependent variables and Spearman's correlation coefficient were used to determine the relationship between not normally distributed variables. In addition, the Pearson's test was performed to detect the relationship between normally distributed variables, and $P \leq 0.05$ was accepted as statistically significant. In the modelling of categorical dependent variables, the binary regression analysis was used. Statistically significant values are indicated in bold in Tables.

Results

The demographic, anthropometric, biochemical, and metabolic characteristics of participants are summarized in Table 1. At the baseline, 350 participants were included into the cigarette cessation program, and of

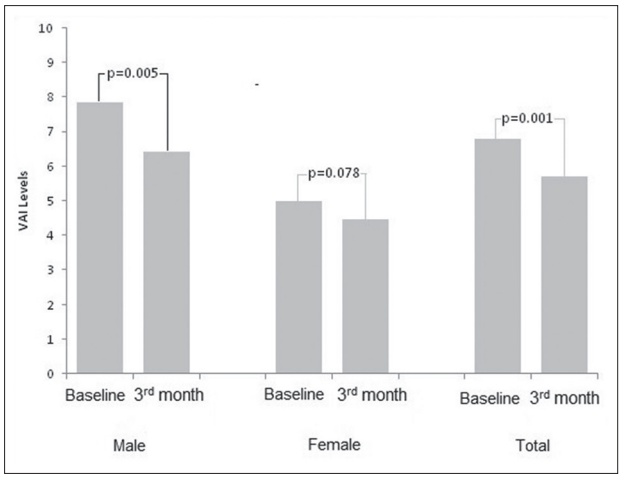

Figure 1: The changes seen in VAI levels after quitting smoking according to total and genders. VAI: Visceral adiposity index

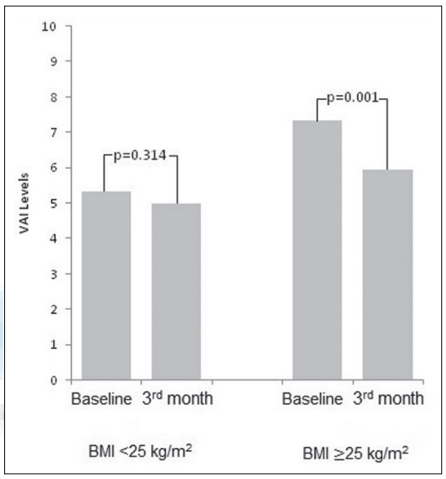

Figure 2: The changes seen in VAI levels after quitting smoking in participants with normal weight and in overweight/obese participants. VAI: Visceral adiposity index

350 participants, 70 (20%) completing the study were enrolled into the analyses (see Diagram 1). In terms of comparing both genders, male smokers were found to smoke more intensely and to start smoking at an earlier age, whereas female smokers managed to quit smoking at a longer period [Table 1]. Even though the scores of weight, WC, TG, and VAI were found to be higher in men, compared to women at the baseline, HDL-cholesterol was observed to be higher among women. In the analyses performed at the 3rd month, the levels of weight, WC, and TG were found to be higher in men, whereas HDL-cholesterol was higher in women [Table 1]. VAI levels, however, were observed to be similar in both genders in the analyses performed at the 3rd month, and no gender difference was present between the male and female smokers in terms of VAI changes found at the 3rd month, compared with the baseline values.

Table 1: Some demographic characteristics and study parameters before and after smoking cessation

	Total (*n*=70)	Male (*n*=44)	Female (*n*=26)	*P**
Age (year)	42.0±1.0	42.0±2.0	41.0±1.00	0.648
Starting age to smoke (year)	16.87±0.45	16.02±0.56	18.31±0.69	0.007
Number of cigarettes smoked per day	23.29±1.02	24.73±1.12	20.85±1.93	0.031
Duration of smoking (year)	23.07±1.18	24.73±1.53	20.27±1.79	0.085
Number of quitting attemps of smoking	1.47±0.18	1.44±0.25	1.53±0.23	0.349
Duration length of quitting attemp (day)	215.65±101.25	55.80±22.37	615.25±277.88	0.013
FNAT score	6.07±0.31	5.770±0.37	6.58±0.52	0.188
Height (cm)	158.98±4.75	160.57±6.63	156.29±1.60	<0.001
Baseline weight (kg)	78.11±1.95	83.00±2.72	69.85±1.60	<0.001
Baseline WC (cm)	95.01±1.39	97.25±1.95	91.23±1.57	<0.001
Baseline BMI (kg/m^2)	27.46±0.58	28.02±0.84	26.50±0.62	0.426
Baseline systolic BP	112.17±1.82	113.26±2.32	110.38±2.96	0.177
Baseline diastolic BP	72.39±1.20	73.14±1.49	71.15±2.02	0.316
Baseline CO levels in expiration (ppm)	5.78±0.44	6.33±0.62	4.88±0.52	0.206
Baseline TG (mg/dL)	168.97±14.56	199.25±21.38	117.73±8.79	0.004
Baseline HDL-cholesterol levels (mg/dL)	40.50±1.14	36.84±1.28	46.69±1.57	<0.001
Baseline VAI levels	6.79±0.64	7.84±0.95	4.99±0.85	0.045
3rd-month weight (kg)	80.30±1.88	84.14±2.70	73.80±1.55	0.006
3rd-month WC (cm)	96.74±1.34	97.25±1.95	91.23±1.47	0.036
3rd-month BMI (kg/m^2)	28.25±0.56	28.40±0.83	27.98±0.57	0.126
3rd-month systolic BP (mm/Hg)	109.04±1.64	110.00±2.35	107.50±2.02	0.654
3rd-month diastolic BP (mm/Hg)	72.47±1.30	72.26±1.75	72.81±1.92	0.639
3rd-month CO levels in expiration (ppm)	0.77±0.25	0.89±0.38	0.58±0.26	0.801
3rd-month TG levels (mg/dL)	160.43±10.92	184,39±15.55	119.88±8.80	0.006
3^{r}d-month HDL-cholesterol levels (mg/dl)	44.44±1.16	40.75±1.29	50.67±1.66	<0.001
3rd-month VAI levels	5.70±0.64	6.42±0.62	4.48±0.34	0.126
Percentage changes in VAI	16.04±6.26	18.20±7.94	10.28±6.90	0.135

FNAT=Fagestrom's Nicotine Addiction Test; WC=Wwaist circumference; BMI=Body mass index; BP=Blood pressure; CO=Carbon monoxide; VAI=Visceral adiposity index; TG=Triglyceride; HDL-cholesterol=High density lipoprotein-cholesterol; *indicates the comparison between male and female subjects

Table 2: The changes of study parameters during 3-month study period

	Baseline	3rd-month	*P*
Weight (kg)			
Total	78.11±1.95	80.30±1.88	<0.001
Male	83.00±2.72	84.14±2.70	0.024
Female	69.85±1.60	73.80±1.55	<0.001
BMI (kg/m^2)			
Total	27.46±0.58	28.25±0.56	<0.001
Male	28.02±0.84	28.40±0.83	0.028
Female	26.50±0.62	27.98±0.57	<0.001
WC (cm)			
Total	95.05±1.39	96.74±1.43	<0.001
Male	97.25±1.95	98.59±1.95	0.009
Female	91.23±1.47	93.60±1.26	0.008
Systolic BP (mmHg)			
Total	112.17±1.82	109.04±1.64	0.132
Male	113.26±2.32	110.38±2.96	0.177
Female	110.00±2.35	107.50±2.02	0.654
Diastolic BP (mmHg)			
Total	72.39±1.20	72.47±1.30	0.663
Male	73.14±1.49	71.15±2.02	0.316
Female	72.26±1.75	72.81±1.92	0.639

Contd...

Table 2: Contd...

	Baseline	3rd-month	*P*
CO levels in expiration breath			
Total	5.78±0.44	0.77±0.25	<0.001
Male	6.33±0.62	0.89±0.38	<0.001
Female	4.88±0.52	0.58±0.26	<0.001
HDL-cholesterol levels (mg/dL)			
Total	40.50±1.14	44.44±1.16	<0.00
Male	36.84±1.28	40.75±1.29	<0.001
Female	46.69±1.57	50.67±1.66	0.002
TG levels (mg/dL)			
Total	168.97±14.56	160.43±10.92	0.411
Male	199.25±21.38	184,39±15.55	0.333
Female	117.73±8.79	119.88±8.80	0.979
VAI levels			
Total	6.79±0.64	5.70±0.64	0.001
Male	7.84±0.95	6.42±0.62	0.005
Female	4.99±0.85	4.48±0.34	0.078

BMI=Body mass index; WC=Waist circumference; BP=Blood pressure; CO=Carbon monoxide; TG=Triglyceride; HDL-cholesterol=High density lipoprotein-cholesterol; VAI=Visceral adiposity index

Table 3: The comparison of VAI levels and various parameters in subjects smoking ≤20 and >20 cigarettes per day

	Those smoking ≤20 cigarettes per day (*n*=46)	Those smoking >20 cigarettes per day (*n*=24)	*P*
Age (year)	42.00±2.00	40.00±2.00	0.590
Baseline weight (kg)	75.37±2.48	83.38±2.91	0.008
Baseline WC (cm)	92.59±1.82	99.67±1.79	0.001
Baseline BMI (kg/m^2)	26.92±0.79	28.48±0.72	0.042
Baseline systolic BP	109.78±2.10	116.67±3.33	0.073
Baseline diastolic BP	70.67±1.33	75.63±2.28	0.084
Baseline HDL-cholesterol levels (mg/dL)	41.26±1.49	39.04±1.73	0.382
Baseline TG levels (mg/dL)	147.26±16.15	210.58±27.60	0.004
Baseline VAI levels	5.83±0.69	8.62±1.27	0.012
3rd-month weight (kg)	77.73±2.41	85.23±2.73	0.010
3rd-month WC (cm)	94.62±1.75	100.79±1.77	0.004
3rd-month BMI (kg/m^2)	27.77±0.77	29.15±0.69	0.067
3rd-month systolic BP (mm/Hg)	107.61±1.78	111.67±3.29	0.466
3rd-month diastolic BP (mm/Hg)	70.18±1.43	76.67±2.38	0.024
3rd-month HDL-cholesterol levels (mg/dl)	44.97±1.27	43.42±2.39	0.356
3rd-month TG levels (mg/dL)	142.87±12.41	194.08±19.78	0.013
3rd-month VAI levels	4.96±0.45	7.10±0.84	0.037
Percentage changes in VAI	14.86±7.68	17.49±9.71	0.776

WC=Waist circumference; BMI=Body mass index; BP=Blood pressure; VAI=Visceral adiposity index; HDL-cholesterol=High density lipoprotein-cholesterol; TG=Triglyceride

Compared to the baseline values, it was seen that weight, WC, BMI, and HDL-cholesterol levels increased, whereas the levels of VAI and CO in expiration breath decreased significantly [Table 2] [Figure 1]. In the subgroup analyses, VAI levels were seen to decrease significantly in men (P = 0.005), but the decrease in women to be insignificant (P = 0.078) [Figure 1]. It was also detected that weight, BMI, WC, and HDL-cholesterol levels increased in both genders, but TG levels remained unchanged.

When the participants were divided into two new subgroups as BMI <25 kg/m^2 (n = 19) and BMI ≥25 kg/m^2 (n = 51), VAI levels were found to decrease from 7.33 ± 0.82-5.96 ± 0.54 (P < 0.001) in those with BMI ≥25 kg/m^2, whereas no significant change was observed in those with BMI <25 kg/m^2 [Figure 2].

When the participants were re-classified at the baseline according to the number of cigarettes smoked per day, the levels of VAI, body weight,

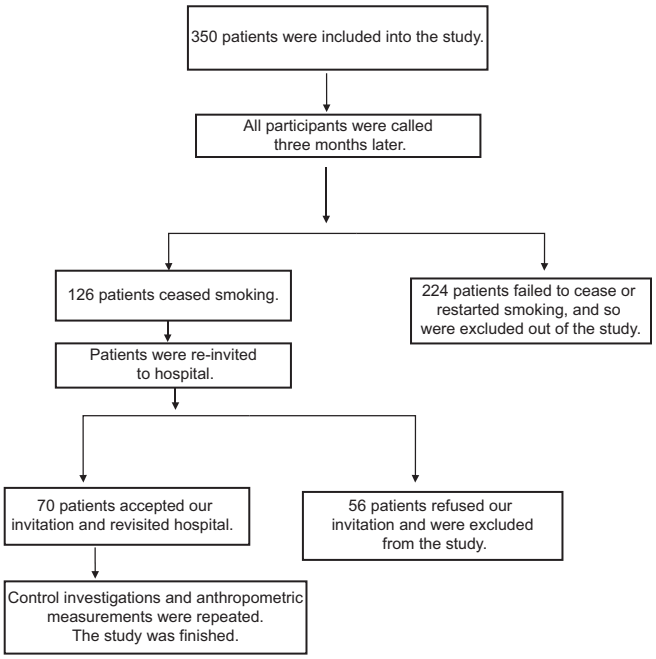

Diagram 1: Flow diagram

BMI, WC, and TG were found to be higher in those smoking >20 cigarettes/day, compared to those smoking ≤20 cigarettes/day. Weight, WC, diastolic BP, TG, and VAI levels found at the 3rd month were seen to be higher in those smoking >20 cigarettes/day, compared to those ≤20 cigarettes/day. However, when the rates of changes were compared during the study period, no significant difference was observed between those smoking >20 and ≤20 cigarettes/day in terms of VAI levels [Table 3].

In correlation analysis, a positive correlation was determined between VAI levels at the 3rd month, and the number of cigarettes smoked per day and systolic and diastolic BP measured at the 3rd month.

In the paired-logistic regression analysis, each mean 1 mg/dL increase at TG levels caused 1.168-fold increase at VAI levels (P = 0.001), while each 1 mg/dL increase at HDL-cholesterol levels led to 1.715-fold decrease (P = 0.005). BMI and WC variables were omitted out of analysis because of they were insignificant in the regression model.

Discussion

In the present study, VAI levels were found to decrease, although the levels of BMI, WC, and HDL-cholesterol increased at the 3rd month after quitting smoking, compared to the baseline values. Moreover, after performing the subgroup analyses, a significant decrease in VAI levels was detected in overweight and/or obese participants at the 3rd month according to the baseline; the same significant finding was also seen in men at the 3rd month, compared to the baseline levels. In addition, we found higher levels of VAI in those smoking >20 cigarettes/day.

To the best of our knowledge, our study is the first to evaluate VAI levels after smoking cessation. Although central or abdominal obesity is seen at a higher rate in current or former smokers, smokers are known to be leaner, compared to nonsmokers.[7] On the other hand, weight gain and obesity become increased in such individuals after quitting smoking,[12] and as well as the increase seen in obesity rates and leading to MetS and its components, and CVDs, obesity also causes an unwanted condition as a barrier in smokers wishing to quit smoking. To evaluate weight gain or obesity, we frequently use parameters such as BMI or WC; however, these two parameters are also affected by the factors, such as race, ethnicity, racial differences, gender, hydration status, body/muscle structure, and subcutaneous adipose tissue. Although recommended in the description of MetS, WC does not precisely indicate real VAT; so, the volumes of subcutaneous or VAT are likely to be different in different individuals with the same WC levels. However, VAT is more active and atherogenic, compared to subcutaneous tissue.[20] Today, VAI levels are recommended by some researchers today to detect or evaluate cardiometabolic risks in the different patient segments and the general population. In several studies, VAI, followed by BMI, WC, and waist-hip ratio, was recommended as the best parameter to predict the presence of MetS and its components.[33,34] Among the levels of BMI, WC, HDL-cholesterol, and TG as four parameters of VAI, the first three out of TG were found to increase in our study after smoking quitting, and despite the increase in three parameters, VAI levels were detected to show a decrement after smoking cessation. Given that TG and HDL-cholesterol levels had primarily effects on VAI levels in logistic regression analysis (1.168-fold vs. 1.725-fold, respectively), and considering the decreases at VAI levels, we concluded that the main determinant was the increase at HDL-cholesterol levels.

In a large cross-sectional study performed in 4656 Korean men by Lee *et al*.,[30] the current and former smokers were reported to have higher VAT volume evaluated by CT, compared to never smokers. As well as suggesting that longer smoking duration, higher daily cigarette consumption, and shorter abstinence duration were associated with increasing VAT, they also reported that the highest levels of VAT were detected in those with 2-year abstinence and similar mean VAT in ex-smokers with longer than 20-year smoking duration,

compared to never-smokers. As a limitation of our study, no comparison between smokers and never smokers was performed with respect to VAI levels, as an indicator of VAT functions, due to lack of a control group. However, although the highest levels of VAT were found at the 2nd year after quitting smoking in the study by Lee *et al*., the levels of VAI were found to decrease at the 3rd month after quitting smoking. Based on the results of so-called study and our findings, it may be speculated that positive and beneficial changes are seen in visceral adipocytes functions, evaluated with the decrease in VAI levels, even if VAT increases after quitting smoking. The decrease seen in VAI levels may also be a contributor to the decrease in the development of CVDs after quitting smoking.

Various studies report that smoking intensity,[26,35-38] younger age,[36,38,39] higher BMI,[12,35] and lower education levels[35] are associated with the severity of weight gain. In another study performed by Jain *et al*.,[12] it was also reported that individuals smoking 20 cigarettes/day gained weight at a higher rate (5.1 kg), compared to those smoking 5 cigarettes/day (1.8 kg), and that overweight/obese smokers were more prone to weight gain during 20-year follow-up period, compared to nonobese smokers. Although body weight, BMI, WC, TG, and VAI levels were higher in those smoking >20 cigarettes/day, no significant change was observed in these parameters during the study period after smoking cessation.

As another important finding of our study, VAI levels were found to decrease significantly after quitting smoking only in overweight/obese cases, compared to nonobese smokers. With respect to VAI parameters, we detected that no significant change developed in all of the four parameters during the study, but a decrease close to the significance level was observed only in TG levels, and after performing subgroup analyses with respect to gender differences, a significant decrease was observed only in men with BMI ≥25 kg/m^2. Although no significant change developed as to four VAI parameters during the study in this subgroup, VAI levels were seen to decrease as a result of the harmony between these parameters. As different from our results, Krukowski *et al*.[40] reported that nonobese and overweight cases quitting smoking recently were prone to weight gain at a higher rate, compared to the obese.

Cigarette smoking is known to increase plasma total cholesterol, low-density lipoprotein cholesterol and TG levels, and to decrease HDL-cholesterol levels.[41] It was also shown that smoking cessation has beneficial effects on atherogenic dyslipidemia. In the study performed by Takata *et al*.,[29] an improvement was found in cholesterol efflux capacity and HDL inflammatory index as an indicator of the improvement of HDL functionality, although no changes were detected at the levels of HDL-cholesterol and its subgroups after quitting smoking. In another study performed by Nilsson *et al*.,[42] a significant increase was reported in HDL-cholesterol levels after smoking cessation, although no change was observed in TG levels. As a limitation of our study, no other lipid parameters, out of HDL-cholesterol and TG, were evaluated. TG levels at the baseline and 3rd month were found higher in men, while HDL-cholesterol levels detected during the same periods were observed to be higher in women. During the study period after quitting smoking, HDL-cholesterol levels significantly increased in both genders, whereas no change was seen as to TG levels.

In our study, VAI levels were seen to be higher in men at the baseline, compared to women. However, VAI levels were observed to be similar at the end of the study, and the changes of percentages were also similar in both genders. On the other hand, as another interesting finding of this study, a significant decrement in VAI levels was detected only in men after the 3rd month of quitting smoking, compared to the baseline levels. We consider that the condition needs explaining as a new and interesting finding. In several previous studies, it was reported that gender differences had no effects on weight gain after quitting smoking.[12,36] In a meta-analysis published by Locatelli *et al*.,[38] gender differences were reported to have no effects on weight gain after quitting smoking; however, considering that the study population was re-classified as light and heavy smokers by Locatelli *et al*., women smoking heavily were detected to gain weight higher, compared to men. On the other hand, men described as light smokers were determined to gain weight higher, compared to women. However, body weight, BMI, WC, and HDL-cholesterol levels were found to increase in both genders in our study, whereas no change was observed in TG levels only in men during the study period. Given that CVDs are seen more commonly in men, we consider that the decrement seen in VAI levels plays an important role to reduce CVD risks, especially in male smokers.

Weight gain experienced after quitting smoking dissuades smokers from quitting attempts,[14] and so smokers are recommended to care for dieting or nutritional advice from health-care providers after quitting period to prevent obesity.[43,44] In our study, we recommended no advice on their dietary habitus, caloric intake or exercise, other than routine practices. Despite lack of our recommendation, especially on calory restrictions, our cases were detected to gain weight, but the VAI levels still decreased significantly. Hence, we

consider that if smokers display insufficient behaviors in dietary habitus, health-care providers should not insist on strict dietary regimes and that quitting smoking is more significant than weight gain, as to decreasing the risks of CVDs.

Although 126 (36%) participants self-reported the quittance and discontinuation of smoking through phone calls, only 70 (20%) participants came to the outpatient clinic for controls, and the quittance of 70 participants was confirmed by expiration breath CO analyses. The success rates of smoking cessation in our cases were similar to those detected in other studies.[45]

All participants in our study were given Bupropion (2 × 150 mg) during the study period. Bupropion is known to have a slight effect on weight loss with its central effect and positive effects on metabolic parameters.[46] Although VAI levels were decreased, an increase was detected on the weight and WC of our participants despite the treatment with Bupropion. The absence of a control group not treated with Bupropion was one of the limitations in our study.

Conclusions

Although body weight, BMI, and WC levels increased in our cases after quitting smoking, VAI levels were decreased significantly, especially in men or overweight/obese population. Given the association between smoking and CVDs, smoking cessation should be given more importance, compared to weight gain, in the prevention MetS and CVDs. In profit/loss analysis, we consider that smoking gives more harm than obesity.

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Conflicts of interest

There are no conflicts of interest.

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