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Relationship between short-term smoking and insulin resistance in asymptomatic young adults

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Abstract

Obesity, sedentary life, advanced age, and smoking are the factors that increase the insulin resistance. The aim of the present study was to investigate the relationship between short-term smoking and insulin resistance in asymptomatic adults without obesity, advanced age, high blood glucose levels and hypertension. In this study we included 240 participants (120 non-smoker, 120 smoker) aged between 18-35 who admitted to internal medicine outpatient clinic from July 2018 to January 2019. Participants' body mass index, waist-hip ratio, systolic and diastolic blood pressure, triglycerides, high density lipoprotein cholesterol, low density lipoprotein cholesterol, fasting blood glucose, insulin, hemoglobin A1c levels were measured. Homeostatic model assessment for insulin resistance values were calculated. There was no statistically significant difference between the two groups with respect to body mass index, age, systolic and diastolic blood pressure, low density lipoprotein cholesterol, triglyceride, insulin, fasting blood glucose, hemoglobin A1c and homeostatic model assessment for insulin resistance values ($p > 0.05$). High density lipoprotein cholesterol level in smokers was found to be statistically significantly lower than non-smokers ($p = 0.02$). Our study has shown that there is no relationship between short- term smoking and insulin resistance. Insulin resistance develops with increase in smoking.

Keywords: Insulin resistance, metabolic syndrome, smoking

Introduction

Insulin resistance is the decreased sensitivity of tissues to insulin effect [1]. Although it is a condition that can be seen in physiological conditions such as puberty, pregnancy, old age, physical inactivity and drug intake (corticosteroids, some oral contraceptives, diuretics), the mechanisms that cause insulin resistance can be grouped under the following four reasons: a) Pre- receptor causes: Abnormal insulin and insulin antibodies, blood flow disorder b) Receptor causes: Decreased number and affinity of receptors c) Post-receptor causes: Abnormal signal transduction and phosphorylation d) Decrease of glucose transporter type 4 (GLUT-4). Causes of insulin resistance can be grouped as obesity, genetic and environmental (hormones, excess calorie food consumption, weight gain, sedentary life, smoking and aging.....) factors.

Smoking, another factor in the emergence of insulin resistance, has a direct toxic effect on pancreatic tissue [2,3]. It has been shown that nicotine, carbon monoxide and other agents resulting from smoking directly cause insulin resistance [4,5]. Insulin response after oral glucose intake is higher in smokers than non-smokers [4]. There is a relationship between the amount of cigarettes smoked and insulin resistance [6].

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In our study, we investigated the effects of smoking on body mass index, waist-hip ratio, blood glucose, insulin, lipid parameters and blood pressure by excluding factors such as advanced age, obesity, diabetes, impaired fasting glucose, impaired glucose tolerance, hypertension, which will lead to insulin resistance. We aimed to evaluate the relationship between smoking and insulin resistance.

Material and Methods

Study Design

In this study we included 240 participants (120 non-smoker, 120 smoker) aged between 18-35 who admitted to internal medicine outpatient clinic from July 2018 to January 2019. All participants were healthy asymptomatic individuals. Voluntary consent form was received from all participants. Ethical approval was obtained from the local ethics committee (approval number: 54022451-050.05.04-1965).

The case group consisting of smokers was divided into groups as < 3 packs / year (Group 1, n = 19), 3-7 packs / year (Group 2, n = 36) and >10 packs / year (Group 3, n = 65) according to their duration of smoking. The control group consisted of healthy individuals who did not smoke (n = 120). Waist-hip ratio, systolic and diastolic blood pressure, triglyceride, low density lipoprotein

(LDL) cholesterol, high density lipoprotein (HDL) cholesterol, fasting

blood glucose (FBG), insulin, glycosylated hemoglobin (hemoglobin A1c, HbA1c) measurements were made. Body mass index (BMI) was calculated as body weight (kg) divided by the square of height (m^2). Today, it is a test that is used to evaluate peripheral insulin resistance, which evaluates beta cell function and insulin resistance with the use of homeostasis model assesment (HOMA) glucose and insulin (or C-peptide), and provides a practical examination of especially large patient population. The average of three blood samples taken 5 minutes apart after ten hours of absolute fasting is taken. However, in practice, mostly a single blood sample is taken and the formula below is used. In our study, HOMA values were used to determine insulin resistance.

HOMA-IR = [Fasting glucose (mmol/L) × Fasting insulin (mU/ml)] / 22,5 [7].

Exclusion criteria were being over the age of 35, BMI >30 kg / m^2, blood pressure >120/80 mmHg, having a history of coronary artery disease, diabetes mellitus, hyperlipidemia, receiving antihypertensive, antihyperlipidemic, antihyperglycemic medication therapy, impaired fasting glucose and / or impaired glucose tolerance, having a smoking history and quitting before and during study.

Statistical Methods

Statistical analyses were performed using SPSS version 21.0 (SPSS Inc. Chicago, IL, USA). In comparison of smokers and non-smokers in terms of continuous measurements, the t-test of the difference between two independent sample averages was used, and Pearson chi-square test was used in comparison of these two groups in terms of categorical measurements, and the results were expressed as frequency and percentage (%). In addition, one-way analysis of variance and Pearson chi-square tests were used in comparison of the 3 groups related to smoking periods created in smokers in terms of these measurements. In the examination of the factors related to HOMA-IR, multiple linear regression analysis was performed in smokers and non-smokers separately. Fasting blood glucose and insulin values used in the calculation of HOMA-IR were not used when performing multiple linear regression analysis in cascading and non-smoker groups. Statistically, p values less than 0.05 are considered significant.

Results

120 healthy-non smoker volunteers and 120 healty smoker volunteers were included in the study. There was no statistically difference between the two groups with respect to age, gender distribution, waist-hip ratio, systolic and diastolic blood pressures, and BMI. HDL cholesterol level was lower in the smoker group (p = 0.02). Although the LDL cholesterol level was higher in the smoker group, it was not statistically significant (p = 0.43). Total cholesterol and triglyceride values were also not statistically significant (p = 0.96, p = 0.93, respectively) (Table 1).

The fasting blood glucose and insulin values of the smoker group were higher than the non- smoker group. However, this finding was not statistically significant (p = 0.25, p = 0.23 respectively). When the HOMA-IR and postprandial blood glucose data of the cases were examined, no statistically significant difference was found (p = 0.21 and p = 0.89, respectively) (Figure 1).

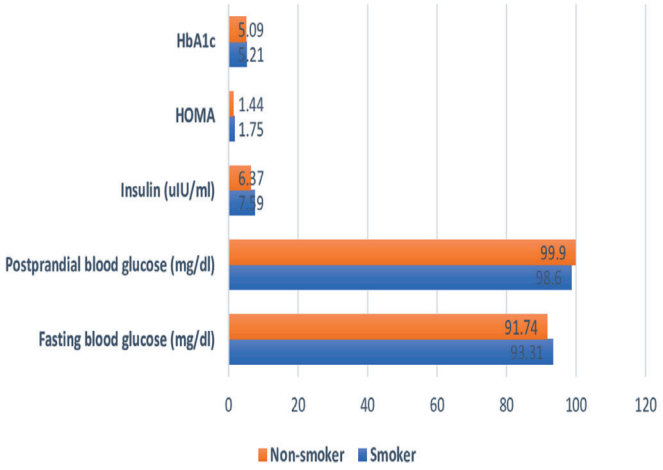

Figure 1. Distribution of metabolic values of the smoker and non-smoker group

Table 1. Demographic and laboratory features of smokers and non-smokers.

Variables	Smoker group, (n = 120)	Non-smoker group, (n = 120)	p value
Age, years	27.59 ± 4.53	25.19 ± 5.02	0.07
BMI, (kg / m²)	22.81 ± 3.19	23.01 ± 3.02	0.81
Waist-hip ratio	0.86 ± 0.08	0.84 ± 0.06	0.93
SBP, mmHg	111.50 ± 9.75	111.90 ± 9.15	0.95
DBP, mmHg	72.00 ± 8.59	73.00 ± 8.02	0.63
Triglycerides, mg/dl	94.31 ± 42.39	96.59 ± 60.23	0.93
Total C, mg/dl	163.07 ± 30.38	164.01 ± 31.01	0.96
HDL-C, mg/dl	44.42 ± 9.91	49.31 ± 11.31	0.02*
LDL-C, mg/dl	97.89 ± 23.51	93.98 ± 27.11	0.43
FBG, mg/dl	93.31 ± 6.01	91.74 ± 7.31	0.25
PPBG, mg/dl	98.60 ± 15.79	99.90 ± 16.79	0.89
HbA1c, %	5.21 ± 0.41	5.09 ± 0.29	0.41
Fasting serum insulin, µIU/ml	7.59 ± 5.57	6.37 ± 4.00	0.23
HOMA-IR	1.75 ± 1.30	1.44 ± 0.91	0.21
Alcohol	10	0	0.04*

Variables are given as n prevalence or mean± SD, *p < 0.05
Abbreviations: BMI, body mass index; SBP, Systolic blood pressure;DBP, Diastolic blood pressure;Total C, totalcholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; FBG, fasting blood glucose; PPBG, postprandial blood.

Smokers were classified as < 3 packs / year (Group 1, n = 19), 3-7 packs / year (Group 2, n = 36) and >10 packs / year (Group 3, n = 65) according to the duration of smoking. It was divided into three groups. When the group characteristics were compared, there was no statistical significance between the three groups in terms of age, gender, BMI, waist-hip ratio, systolic and diastolic blood pressures. When the laboratory results were examined, triglyceride, total cholesterol, HDL cholesterol and LDL cholesterol values were lower in the non-smoker group, but were not statistically significant.

When the smoker group was compared in terms of HbA1c, insulin and HOMA-IR values, it was seen that these values increased as the amount of cigarettes consumed daily and duration of smoking increased. This increase was not statistically significant (Table 2).

When multiple linear regression analysis was performed in the smoker group, it was found that waist-hip ratio and triglyceride were statistically significant independent predictive factors for HOMA-IR. In non-smokers, it was found that BMI, total cholesterol, and LDL cholesterol were statistically significant independent predictive factors for HOMA-IR. There was no statistically significant difference between the groups formed among the participants according to their smoking status. The gender distribution of all 3 groups is presented in Table 3.

Table 2. Characteristics of groups according to smoking periods.

Variables	Group 1 (n = 19)	Group 2 (n = 36)	Group 3 (n = 65)	p value
Age, years	27.3 ± 4.38	26.51 ± 3.71	26.98 ± 4.68	0.83
BMI, kg / m²	23.95 ± 3.41	22.21 ± 3.56	22.81 ± 3.31	0.36
Waist-hip ratio	0.79 ± 0.12	0.79 ± 0.11	0.83 ± 0.11	0.39
SBP, mmHg	113.41 ± 8.43	112.24 ± 7.47	112.42 ± 10.13	0.91
DBP, mmHg	72.71 ± 7.39	73.29 ± 7.23	72.61 ± 9.91	0.89
Triglyceride, mg / dl	98.24 ± 21.17	95.54 ± 45.05	96.71 ± 47.51	0.99
Total C, mg / dl	173.16 ± 30.02	157.07 ± 36.14	163.88 ± 28.16	0.47
HDL-C, mg / dl	48.15 ± 9.11	43.20 ± 11.10	44.51 ± 9.59	0.73
LDL-C, mg / dl	105.51 ± 24.95	91.90 ± 26.12	98.29 ± 22.24	0.43
FBG, mg / dl	91.58 ± 7.41	94.29 ± 6.85	93.21 ± 5.14	0.61
PPBG, mg/dl	94.92 ± 19.62	97.96 ± 12.84	100.38 ± 17.28	0.64
HbA1c, %	5.11 ± 0.41	5.15 ± 0.36	5.17 ± 0.41	0.68
Fasting serum insulin, µIU/ml)	6.39 ± 3.28	7.20 ± 4.18	8.21 ± 6.69	0.41
HOMA-IR	1.46 ± 0.82	1.69 ± 1.11	1.91 ± 1.49	0.18

Variables are given as mean ± SD
Abbreviations: BMI, body mass index; SBP, Systolic blood pressure; DBP, Diastolic blood pressure; Total C, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; FBG, fasting blood glucose; PPBG, postprandial blood glucose; HbA1c, glycosylated haemoglobin; HOMA-IR, homeostatic model assessment for insulin resistance.

Table 3. Distribution of gender by groups according to smoking periods.

Variable	Group 1 (n = 19) n (%)	Group 2 (n = 36) n (%)	Group 3 (n = 65) n (%)	P value
Female	14 (73.68)	22 (61.11)	25 (38.46)	0.11
Male	5 (26.32)	14 (38.89)	40 (61.54)	

Discussion

In our study where we investigated the relationship between smoking with insulin resistance and other metabolic syndrome parameters, no relationship was found between smoking and insulin resistance. When the time and amount of smoking increases, HbA1c, insulin and HOMA values increase and insulin resistance improves [8,9].

Smoking is a major risk factor for cardiovascular disease and atherosclerosis [10-12]. In many studies [13,14] comparing smokers with non-smokers, it was revealed that smokers were hyperinsulinemic and insulin resistant, and these changes led to dyslipidemia [15] and endothelial dysfunction [16].

In a study conducted by Bermudez et al. [4] comparing non-smokers and smokers, it was shown that smokers were hyperinsulinemic and insulin resistant. In a study conducted in our country where people with diabetes and impaired fasting glucose were excluded, it was found that smoking did not affect HOMA-IR in women and decreased it in men [17]. In another cross- sectional study, this finding was confirmed [18]. In our study, fasting blood glucose, insulin levels, and HOMA-IR values were found to be higher in those with high total smoking compared to non-smokers.

However, this finding was not statistically significant. In smokers, triglyceride and waist-hip ratio were associated with HOMA-IR. When the smokers were divided into three groups according to the amount of cigarette consumption among themselves, there was no statistically significant difference even though there was an increase in FBG, insulin and HOMA- IR values in direct proportion to the amount of cigarette consumption.

Also known as atherogenic dyslipidemia, a dyslipidemic profile combining elevated triglycerides, low HDL cholesterol levels and high LDL cholesterol levels can be found together with insulin resistance. Smokers are known to have high triglycerides and low HDL cholesterol levels [19-21]. Since smokers have both insulin resistance and dyslipidemia, the risk of cardiovascular disease has increased in these individuals [22]. In our study, it was found that smokers had high LDL cholesterol and low HDL cholesterol levels. Although triglycerides levels were found high in smokers in similar studies, the levels of triglycerides in smokers were low in our study. Although it was not statistically significant, it was thought that this low levels of triglyceride may be related to lifestyle, genetic predisposition and nutritional habits.

In our study, the young age group was evaluated since there may be a decrease in physical activity and body fitness and an increase in insulin resistance with age. Since individuals between the ages of 18-35 were evaluated and long-term smoking was less in this age group, and since the nutritional habits of the people included in the study were not questioned, we did not find a relationship between smoking and insulin resistance in our study. It can be said that in the light of the studies conducted and the data we obtained, smokers may have insulin resistance, but insulin resistance may not be seen in all smokers.

Our study was conducted on healthy individuals under the age of 35, the duration of smoking in the smoker group, relatively few cases were taken, and our data need to be supported with larger scale studies.

Conclusion

In our study, we compared smokers and nonsmokers between the ages 18-35 to reveal the relationship between smoking and insulin resistance. Since long-term smoking is less in this age group, we could not detect a relationship between smoking and insulin resistance in our study. It can be said that in the light of the studies and the data we obtained, smokers may have insulin resistance, but not all smokers will have insulin resistance. We think that it may contribute to an increase in insulin resistance in the presence of other factors that cause insulin resistance, such as advanced age, obesity, impaired fasting glucose, impaired glucose intolerance, and when smoking increases.

Conflict of interests
The authors declare that they have no competing interest

Financial Disclosure
All authors declare no financial support.

Ethical approval
Ethic approval was received from Local Ethics Committee (Number: 54022451-050.05.04-1965)

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