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Cigarette Smoking as a Relative Risk Factor for Metabolic Syndrome

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Abstract

Background: Metabolic syndrome (MS) is a clustering of risk factors, such as central obesity, insulin resistance, diabetes, hypertension and atherosclerosis. Cigarette smoking is a strong risk factor for cardiovascular diseases; therefore, smoking may be considered as an important risk factor for MS. Smokers are at greater risk than non-smokers to become insulin-resistant and develop cardiovascular diseases. This study aimed to explore the association of cigarette smoking with MS and its components among Iraqi adults who were already smokers for more than 10 years.

Methods: This clinical study was conducted on 80 adult Iraqi subjects, aged 50 - 70 years. Subjects were divided into two groups according to their smoking status. Standard questionnaire was completed regarding smoking habits, medications, past medical history and physical activity. Blood pressure measurements and biochemical analysis involving fasting serum glucose and serum lipid profile (total cholesterol, high-density lipoprotein (HDL)-cholesterol and triglycerides (TG)) were done. The diagnosis of MS was based on the American Heart Association (AHA) and the National Heart, Lung, and Blood Institute (NHLBI) criteria.

Results: According to the AHA definition, this study showed that MS was higher in smokers than in non-smokers with the relative risk for MS. Furthermore, obesity and dyslipidemia were found to be in 65.6% and 80% of both study groups, respectively. Systolic (P = 0.026) and diastolic blood pressures (P = 0.03) were significantly higher in smokers compared with non-smokers. The present study clearly showed that total serum cholesterol, HDL-cholesterol and low-density lipoprotein (LDL)-cholesterol serum levels were higher in the smoker group; however, a statistical significance was not obtained. Serum TG level was significantly higher (P = 0.025) in smokers than in non-smokers. The remarkable increase in the prevalence of MS among the smokers and non-smokers was correlated with the involvement of more than one component of MS according to the AHA and NHLBI criteria.

Conclusions: The present study showed that tobacco smoke exposure increases the incidence of or worsens MS. Obesity and overweight give a comparable risk to smoking in adult subjects. Reducing the rate of cigarette smoking provides a beneficial effect on cardiovascular risk factors of this syndrome, such as body weight, blood pressure, blood cholesterol, and serum glucose.

Keywords: Metabolic syndrome; Cigarette smoking; Obesity

Introduction

Metabolic syndrome (MS) is a clustering of risk factors in a phenotypic clinical entity that increases the risk of heart disease and type2 diabetes [1], characterized by the presence of abdominal obesity, elevated blood pressure, high fasting glucose, atherogenic dyslipidemia and insulin resistance [2]. It is now established that components of MS are independently associated with cardiovascular disease (CVD) and type 2 diabetes, becoming targets of therapeutic changes in lifestyle, medications and surgery [3]. The American Heart Association (AHA) and the National Heart, Lung, and Blood Institute (NHLBI) recommend that MS could be identified as the presence of three or more of these components or metabolic risk factors that appear to directly promote the development of atherosclerotic CVD [4]. The prevalence of MS depends on age, gender and ethnic background, and increases with age from 6.7% in the age group of 20 - 29 years to 43.5% in the age group of 60 - 69 years [5]. Looking at various studies around the world, the prevalence varies from 7% in France, 24% in USA, 39.3% in Saudi Arabia to 45.5% and 46% in Tunisia and India, respectively [6]. The clinical management of MS may depend on lifestyle changes and minimizing the components that characterize the disorders mainly cigarette smoking, the incidence of tobacco exposure such as cigarette smoking is exceptionally high in these countries, in which cigarette smoking is the single most important preventable cause of death and illness [6]. The pathogenesis of both MS and the multi-organ damage from chronic tobacco exposure and smoking has been more or less well documented [2]. Individuals who smoke experience a wide range of CVD, insulin resistance, elevated catecholamine levels which contribute to an elevated heart rate and blood pressure, and hypercholerterolemia [7]; thus smokers demonstrate many features that are similar to MS. These similarities indicated that smoking

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Table 1. Descriptive Characteristics of Smokers and Non-Smokers

Parameter	Group A: smokers (N = 40)	Group B: non-smokers (N = 40)
Age (years)	53.50 ± 4.19	56.85 ± 6.49
BMI (kg/m^2)	33.19 ± 7.15	31.76 ± 4.94
Waist (cm)	105.10 ± 22.99	102.15 ± 11.50
SBP (mm Hg)	128.25 ± 13.59*	120.0 ± 10.00
DBP (mm Hg)	83.25 ± 9.07*	77.00 ± 9.51

Data presented as mean ± SD. *Significance compared to non-smoker, P < 0.05. SBP: systole blood pressure; DBP: diastole blood pressure.

might be related to increased risk of the MS. The association of these independent factors, and the mechanism by which it influences each other needs to be elucidated further, as both pose grate threat to public health [6, 7]. This study aimed to determine whether parts of the adverse effect of smoking are contributing factors for the presence of MS in adults who were already smokers for more than 10 years.

Materials and Methods

This clinical study was conducted on adult Iraqi volunteers and approved by the scientific and ethic committee for clinical research there. All participants were informed of the nature of the screening and all were subjected to standard questionnaire comprising smoking habits, medications, past medical history, physical activity, and blood pressure. Eighty males and females aged 50 - 70 years participated in the study and were divided into two groups according to their smoking status. Group A (smokers) included 40 smokers with a mean age (± standard deviation (SD)) of 53.5 ± -4.19 years, and age range of 50 - 63 years, who were heavily smokers for more than 10 years at past. Group B (non-smokers) included 40 non-smokers with a mean (± SD) age of 56.85 ± 6.49 years, and age range of 50 - 70 years, who were apparently healthy and never smoked at past.

Written informed consent was obtained from each participant. A checklist including age, sex, smoking, amount of smoking, blood pressure, weight, height, body mass index (BMI), and waist circumference was obtained from each participant. Blood pressure was measured by a standard sphygmomanometer after 15 min rest in a sitting position. Blood pressure was measured twice with at least 30 min intervals and the mean of two blood pressure measurements was considered as participant's blood pressure. Waist circumference was measured at the midpoint between the lowest rib and the upper border of the right iliac crest, while body weight and height were taken from each subject nearest to each 0.1 cm. MS was defined based on the AHA/NHLBI criteria. According to this definition, participants with three or more of the following five criteria had MS: 1) abdominal obesity determined by elevated waist circumference (≥ 102 cm in men and ≥ 88 cm in women); 2) elevated triglycerides (TG) (≥ 150 mg/dL); 3) reduced high-density lipoprotein (HDL)-cholesterol (< 40 mg/dL in men and < 50 mg/dL in women); 4) elevated blood pressure (systolic blood pressure (SBP) ≥ 130 mm Hg or diastolic blood pressure (DBP) ≥ 85 mm Hg); and 5) elevated fasting glucose (≥ 100 mg/dL). For each subject, the following biochemical test was done based on blood samples taken in the morning after 12 h of fasting. TG, fasting serum glucose (FSG), serum cholesterol and HDL were measured using an enzymatic colorimetric method with readymade kits: glucose kit (Biomaghreb Company), TG kit (Biomaghrab company), HDL kit (Biomaghrab company) and cholesterol kit (Biomaghrab company), while estimation of serum low-density lipoprotein (LDL) was obtained from Friedwald equation: LDL (mg/dL) = total cholesterol - (HDL + TG/5).

Statistical analysis

Data were expressed as mean ± SD and analyzed by SPSS20 software. P < 0.05 was considered as statistically significant. Frequencies were presented as valid percentage; paired *t* test was used for comparison among groups. Relative risk factors such as obesity, dyslipidemia and hypertension for the development of MS among smoker and non-smoker groups were calculated as a ratio of the probability of an event occurring in the exposed group versus a non-exposed group.

Results

This study was conducted on 40 smokers with a mean (± SD) age of 53.5 ± 4.19 years, and age range of 50 - 63 years and 40 non-smokers with a mean (± SD) age of 56.85 ± 6.49 years and age range of 50 - 70 years. According to the AHA definition, this study showed that MS was noted in 55% of the smokers and 45% of the non-smokers. Obesity and dyslipidemia were found to be 65.6% and 80% in both groups, respectively, and hypertension was found to be higher among smokers. Table 1 highlights the descriptive characteristics of smokers and non-

Table 2. Biochemical Parameters Among Smokers and Non-Smokers Groups

Parameter	Group A: smokers (N = 40)	Group B: non-smokers (N = 40)
Glucose(mg/dL)	118.98 ± 20.00	134.11 ± 36.56
Total cholesterol (mg/dL)	284.72 ± 82.53	213.05 ± 61.61
HDL-cholesterol (mg/dL)	115.48 ± 70.19	112.23 ± 70.35
LDL-cholesterol (mg/dL)	79.09 ± 65.96	60.39 ± 53.11
Triglyceride (TG) (mg/dL)	270.68 ± 112.68*	202.15 ± 77.93

Table 3. Relative Risk for Various Metabolic Syndrome Factors Among Smokers and Non-Smokers Groups

Risk factor	Group A: smokers (N = 40)	Group B: non-smokers (N = 40)
Smoking	1.22	-
Obesity	1.44	4.31
Dyslipidemia	2.5	1.42
Hypertension	1.75	0.45

smokers and revealed that there was no significant difference between the two groups in respect to their age, waist circumference, and BMI. SBP and DBP were significantly higher in smoker group (P = 0.026 and P = 0.03, respectively). Table 2 demonstrated that total cholesterol, HDL-cholesterol and LDL serum levels were higher in smoker group; however, statistical significance was not obtained. Serum TG level was significantly higher in smokers than in non-smokers (P = 0.025). Serum glucose level showed impaired glucose tolerance in both groups. As shown in Table 3, the relative risk for MS was found to be 1.22 by smoking; furthermore, other conventional risk factors for obesity, dyslipidemia and hypertension were shown to be 1.44, 2.5 and 1.75 among smokers, while for non-smokers were shown to be 4.31, 1.42 and 0.45, respectively. The distribution of MS components among the smokers and non-smokers is presented in Figure 1 as defined by the AHA and NHLBI criteria.

Discussion

MS is a combination of unfavorable health factors including abdominal obesity, dyslipidemia, hypertension and glucose intolerance [4], and is strongly associated with increased risk of CVD and type 2 diabetes [8]. Smoking has also been implicated as a risk factor for MS. Earlier studies have suggested that overall tobacco use is associated with an increased risk of MS [9, 10], most likely due to its effects on waist circumference, blood lipids and blood pressure [11, 12].

This study demonstrated that the associated risk for developing MS among smokers was 1.22, which was in accordance with other studies that demonstrate smoking as risk factor for developing of MS [13, 14]. On the other hand, obesity relative risk was about 4.31 for developing MS in non-smokers as compared to 1.44 among smokers.

A growing body of evidences indicates that tobacco smoke is independently associated with insulin resistance and that the insulin resistance and tobacco smoke are clearly associated with dyslipidemias [13]. Smokers also demonstrate many features that are similar to MS, and these similarities indicate that smoking might increase the risk of MS [15, 16]. This theory is supported by some scientific studies which were conducted in middle-aged adults who are more likely to develop MS [13, 17]. Some studies among teenagers who were at high risk for being overweight and were also exposed to smoke also reveal a higher risk for developing MS [15, 18]. Other conditions associated with MS include physical inactivity, aging, excess body fat and genetic predisposition which may be a risk factor for developing of MS [19, 20].

Smoking affects the metabolic rate in that the decrease in metabolic rate is usually higher in the smokers due to nicotine suppression, which in turn decreases the release of serotonin and nor adrenaline hormones, giving the concept that smokers have lower anthropometric indexes than non-smokers [21]. Results from previous studies show that increase in smoking

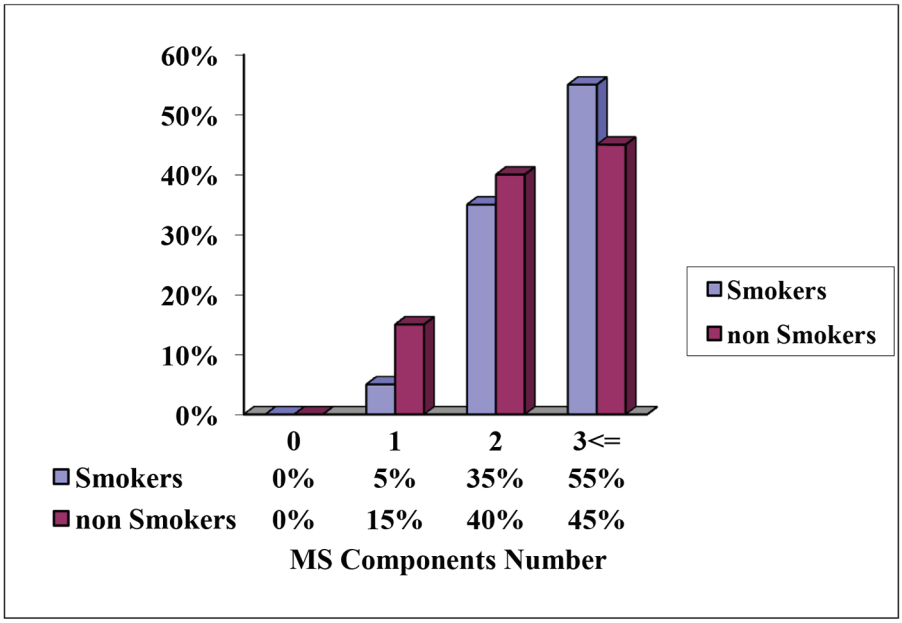

Figure 1. Distribution of the smokers and non-smokers according to the components of metabolic syndrome according to the American Heart Association (AHA) and the National Heart, Lung, and Blood Institute (NHLBI) in valid percentage.

can contribute to abdominal obesity, consistent with our finding [22]. SBP and DBP were higher in the smokers which highlight the effects of smoking status in arterial stiffness, and considered as a strong predictor of smoking-related vascular disease [23]. Smoking itself affects lipid metabolism partly by its contribution to central adiposity and insulin resistance, which can alter the lipid and lipoprotein profile by interfering with fat metabolism [23, 24]. Furthermore, cigarette particulate matter alters catecholamine release which in turn affects VLDL and LDL concentration to favor their accumulation in the blood ending in lower HDL level and promoting atherogenesis [17]. Dyslipidemia relative risk for developing MS was 2.5% among smokers in our study and TG level was significantly higher in smoking group as compared with the non-smokers. This came in accordance with previous studies which showed statistically significant alterations in the levels of lipoproteins and TG [25, 26]. As presented in this study, the association of smoking with insulin resistance and impaired glucose tolerance was reported in many studies previously [3, 27].

Conclusion

From this study, one can conclude that tobacco smoke exposure increases the incidence of MS occurrence and worsens the effect of MS; however, it is not the only risk factor. Obesity and overweight give a comparable risk for MS development in Iraqi adults.

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