

Metabolic Syndrome Components and Living Habits According to Fasting Blood Sugar Measured by Glucometer in Workers

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Abstract

Background: Many studies have underlined the importance of the prevention and management of metabolic syndrome (MetS). Workplace can serve as an important place for prevention and control of MetS. **Objective:** This study was performed to compare the prevalence of MetS, its components and living habits according to Fasting Blood Sugar (FBS) measured by portable glucometer in workers under 40 years old. **Results:** Prevalence of MetS was 11.2% in male workers and 1.8% in female workers. There were significant differences in the number of MetS components in male workers according to FBS level ($p < .05$). Smoking and drinking showed significant relations with high FBS (≥ 126) in men and women respectively ($p < .05$). **Conclusion:** Occupational health manager should effort to manage and control the level of blood glucose of workers in workplace to prevent MetS. Also, effective intervention programs are needed to promote smoking cessation and alcohol-reducing.

Keywords: Alcohol Drinking, Fasting Blood Sugar, Metabolic Syndrome Components, Smoking, Worker

1. Introduction

Metabolic Syndrome (MetS) has been identified to be the risk factor of Cardiovascular Disease (CVD) and type 2 diabetes mellitus (Type 2 DM) through various studies¹⁻³. Even though mechanisms of MetS were not clearly identified insulin resistance is known to play a major role^{4,5}. Hyperglycemia causes inflammation in fatty tissues and liver by secreting acute reactants and this is reported as the cause of atherosclerosis. Additionally, it is well known that hyperglycemic state not only restrains insulin secretion but also causes insulin resistance⁶⁻⁸. CVD and Type 2 DM to Korean people hold 2nd and 5th reason of national cause of death in 2012⁹ and therefore, prediction and management of MetS to prevent these disease are very important¹⁰. Definitions of MetS are a little different in each organization and therefore, suggested standard diagnostic criteria according to the researches are different, but globally prevalence of MetS is approximately from 15-30%^{11,12}. In the Korean population, MetS

prevalence of adults based on national health and nutrition examination survey data is reported at similar level from 20-30%^{13,14}. As these rates are not decreased, active measures are emphasized. Prevalence of MetS tends to occur higher as the age increase. Ervin¹⁵ noted that adults aged 40-59 years were three times more likely to have MetS compared with those ranging in age from 20-39 years. It is important to consistently manage MetS components in advance because MetS is rapidly increasing in the ages of forties and fifties in Korean adults¹⁶ and could lead to premature death and decline of quality of life in old age. It is thought twenties and thirties have lack of interests and the awareness about MetS than older than forties. Therefore, it is necessary to pay attention to these age groups at the level of prevention of MetS. MetS is affected by lifestyles like smoking, drinking and lack of exercise¹⁷⁻¹⁹ as well as by gender and age^{14,17}. Because unhealthy living habits increase the risk of MetS of the workers, it is important to understanding conditions to establish the strategies to improve living habits.

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Isomaa et al²¹ reported who had 40% of impaired glucose tolerance and 10% of normal blood glucose showed MetS. In Moon's research¹⁰, as fasting glucose level increasing within normal range, it was associated with a high frequency of MetS. Hong²² investigated 469 Korean adults who don't have MetS and had normal Fasting Plasma Glucose (FPG). He reported that as the quartile of plasma glucose, 3 year follow-up incidence of the MetS was increased. From these results, if people who have high fasting blood glucose are well managed, it is considered to give positive influences to reduce MetS risk.

Simple blood glucose test by glucometer has been used to monitor blood glucose of workers in workplace. But, studies were executed focusing on screening test of diabetes or blood glucose management targeting the workers who have diabetes. The research aimed the workers who have no diabetes about the relationship between MetS and Fasting Blood Sugar (FBS) level measured by simple blood glucose test. So this study was performed to investigate the relations between the prevalence of MetS and its components, living habits and FBS level measured by glucometer in the working population under 40 years old.

2. Methods

2.1 Sample

This was a cross-sectional study of 1,152 workers (19-34 years) who received an annual health examination at L company in G city. The survey and health examination was conducted from March 25 to April 5, 2013. They completed questionnaires on socio-demographic characteristics, health history and living habits, measurement of anthropometry, blood studies and blood pressure. All participants were no personal history of diabetes. Participants with a history of hypothyroidism and any other chronic diseases were excluded from the study. All subjects provided their informed consent.

2.2 Research Instruments

Waist Circumference (WC) was measured to the nearest 0.1 cm at the midpoint between the highest point of the iliac crest and the lower borders of the rib cage at the mid-axillary line at the end of normal expiration. Body Mass Index (BMI) was calculated as weight (kg)/height² (m²). Blood pressure was measured after respondents had a 5 minutes period of rest.

It was measured using electronic manometer in sitting position. Subjects were fasted at least 8 hours. Blood samples were obtained by venipuncture. The level of FBS was measured by portable glucometer (GM505NA, I-SENS, Korea). An automatic biochemical analyzer (747, Hitachi, Japan) was used to measure enzymatically the levels of Fasting Plasma Glucose (FPG), Triglycerides (TG) and High-Density Lipoprotein Cholesterol (HDL-C). For smoking and alcohol drinking status, subjects were asked whether they were smoking or drinking at the time of the survey. For screening alcohol use, subjects were asked to report alcohol consumed by frequency during the last week and amount per day. Moderate exercise during the past week was defined as those who participated in exercise that caused them to breathe a little harder than usual with time spent 20 minutes or more per day. MetS in this study was defined according to the National Health Insurance Corporation²³. The definition of MetS is based on the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) criteria²⁴, the modified National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP). Abdominal obesity was applied the standard according to the waist circumference of Korean people²⁵. Obesity was defined to be higher than BMI 25 kg/m² or equal using standard, which is suggested based on chronic disease prevalence and body fat of Asian people²⁶. It requires the presence of 3 or more of the following 5 criteria: (1) elevated waist circumference (abdominal obesity), equal or greater than 90 cm in men and equal or greater than 85 cm in women or high BMI (obesity), 25 kg/m² or higher; (2) high BP, systolic 130 mmHg or higher or diastolic 85 mmHg or higher; (3) high fasting plasma glucose, 100 mg/dL or higher; (4) high triglyceride level, 150 mg/dL or higher; and (5) low HDL-C level, less than 40 mg/dL for men and less than 50 for women.

2.3 Data Analysis

Data were analyzed with the SPSS 21 software (SPSS Inc., Chicago, IL, USA). Descriptive statistics such as frequency, mean and standard deviation were used to describe the characteristics of subjects. Pearson correlation coefficient was calculated to identify the relationship between FPG and FBS. Participants were divided into two groups on the basis of the FBS level measured by glucometer, normal FBS (<126) and high FBS (≥126). Independent t-test or chi-square test were used to analyze the difference of the

number of MetS components, prevalence of MetS and living habits by FBS level in each sex.

3. Results

3.1 General Characteristics, Components of MetS and Living Habits of Subject

Of 1,152 workers, 761 (66.1%) of participants were males. As compared with females, males had higher Systolic Blood Pressure (SBP), Diastolic Blood pressure (DBP), TG ($p<.001$) and FPG ($p<.01$). However, females showed elevated HDL-C ($p<.001$) (Table 1).

3.2 Prevalence of MetS and its Components

The most prevalent abnormality for males was abdominal obesity or obesity (39.6%), followed by hypertriglyceridemia (25.8%), hypertension (25.6%). For females, the most prevalent abnormality was low HDL-C (15.3%), followed by abdominal obesity or obesity (14.3%). The prevalence of abdominal obesity or obesity, elevated BP and elevated TG were higher in males than females ($p<.001$). The prevalence of MetS was higher in males (11.2%) than females (1.8%) ($p<.001$) (Table 2).

Table 1. Comparison of characteristics between male and female workers (N = 1,152)

Characteristics	Categories	Male (n=761)	Female (n=391)	<i>p</i>
		n(%) or M±SD	n(%) or M±SD	
General	Age (years)	29.7±2.8	24.6±3.2	<.001
	Height (cm)	173.31±5.37	160.46±4.82	<.001
	Weight (kg)	72.40±9.90	54.30±9.08	<.001
Metabolic syndrome components	WC (cm)	84.79±7.71	71.48±8.39	<.001
	BMI (kg/m ²)	24.08±2.94	21.06±3.23	<.001
	SBP (mmHg)	118.23±10.00	107.95±9.58	<.001
	DBP (mmHg)	75.90±6.15	69.68±6.70	<.001
	FPG (mg/dL)	87.09±9.42	85.36±7.76	.002
	TG (mg/dL)	123.94±82.31	71.34±47.06	<.001
	HDL-C (mg/dL)	49.80±10.03	61.39±12.44	<.001
Living habits	Smoking			<.001
	No	415(54.5)	375(95.9)	
	Yes	346(45.5)	16(4.1)	
	Alcohol drinking			<.001
	No	110(14.5)	140(35.8)	
	Yes	651(85.5)	251(64.2)	
	Exercise, moderate (day/week)	1.14±1.43	1.09±1.50	.628

WC=waist circumference; BMI=body mass index; SBP=systolic blood pressure; DBP=diastolic blood pressure; FPG=fasting plasma glucose; TG=triglyceride; HDL-C=high density lipoprotein-cholesterol.

Table 2. Prevalence of abnormality of individual metabolic components and MetS by sex

Categories	Criteria	Male (n=761)	Female (n=391)	p
		n(%)	n(%)	
Abdominal obesity or obesity	WC $\geq$ 90 cm(M)/85 cm(F) or BMI $\geq$ 25 kg/m ²	301(39.6)	56(14.3)	<.001
High BP	BP $\geq$ 130/85 mmHg	195(25.6)	18(4.6)	<.001
High FPG	FPG $\geq$ 100 mg/dL	44(5.8)	14(3.6)	.106
High TG	TG $\geq$ 150 mg/dL	196(25.8)	16(4.1)	<.001
Low HDL-C	HDL-C <40(M)/50 (F) mg/dL	103(13.5)	60(15.3)	.404
MetS	Number of MetS components $\geq$ 3	85(11.2)	7(1.8)	<.001

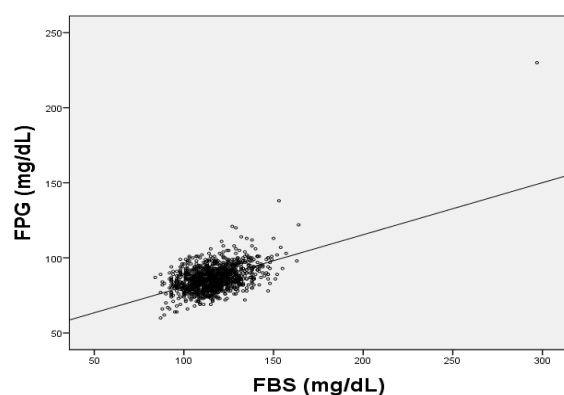
Table 3. Comparison of glucose concentration (mg/dL) (N = 1,152)

Variables	Minimum	Maximum	Mean	Standard Deviation
FPG	60	230	86.50	8.93
FBS	84	297	116.49	13.46

3.3 Relation between FPG and FBS

The mean score of FPG and FBS were 86.50 (SD 8.93) and 116.49 (SD 13.46), respectively. FBS values were higher by 30 mg/dL than FPG (Table 3).

The correlation between FPG and FBS was evaluated. The FPG showed a significant positive correlation with FBS in 1,152 workers ($r = .523$, $p < .001$) (Figure 1).

**Figure 1.** Correlation between Fasting Plasma Glucose (FPG) and Fasting Blood Sugar (FBS) by glucometer in 1,152 workers.

3.4 MetS Components and FBS Measured by Portable Glucometer

Of the 761 male subjects, 148 (19.4%) had high FBS (≥ 126). Of the 391 female subjects, 91 (23.3%) had high FBS.

Table 4 shows the association of FBS level with MetS and number of its components. There was significant difference in the number of MetS components according to FBS level in male workers ($p < .05$). But prevalence of MetS did not show any significant difference between high FBS (≥ 126) group and normal FBS (< 126) group. While in female workers, no difference was found in prevalence of MetS and number of its components between two groups.

3.5 Living Habits and FBS

Smoking in male workers and alcohol drinking in female workers were associated with high FBS (≥ 126) ($p < .05$). However, there was no difference between the degree of exercise (day/week) in high FBS group and those in normal FBS group in both sexes (Table 5).

Table 4. Comparison of number of MetS components and MetS status according to FBS measured by glucometer in 761 male and 391 female workers

Variables	Categories	Male			Female		
		FBS<126 (n=613)	FBS≥126 (n=148)	<i>p</i>	FBS<126 (n=300)	FBS≥126 (n=91)	<i>p</i>
		n(%)	n(%)		n(%)	n(%)	
Number of MetS components	0	224(36.5)	50(33.8)	.047*	207(69.0)	66(72.5)	.134*
	1	207(33.8)	40(27.0)		65(21.7)	17(18.7)	
	2	120(19.6)	35(23.6)		25(8.3)	4(4.4)	
	3	47(7.7)	15(10.1)		2(0.7)	2(2.2)	
	4	14(2.3)	5(3.4)		1(0.3)	2(2.2)	
	5	1(0.2)	3(2.0)		0(0.0)	0(0.0)	
MetS status	Non-MetS	551(89.9)	125(84.5)	.060	297(99.0)	87(95.6)	.054*
	MetS	62(10.1)	23(15.5)		3(1.0)	4(4.4)	

* Fisher's exact test

Table 5. Comparison of living habits according to FBS measured by glucometer in 761 male and 391 female workers

Variables	Male			Female		
	FBS<126 (n=613)	FBS≥126 (n=148)	<i>p</i>	FBS<126 (n=300)	FBS≥126 (n=91)	<i>p</i>
	n(%) or M±SD	n(%) or M±SD		n(%) or M±SD	n(%) or M±SD	
Smoking			.004			.662*
No	350(57.1)	65(43.9)		287(95.7)	88(96.7)	
Yes	263(42.9)	83(56.1)		13(4.3)	3(3.3)	
Alcohol drinking			.874			.032
No	88(14.4)	22(14.9)		116(38.7)	24(26.4)	
Yes	525(85.6)	126(85.1)		184(61.3)	67(73.6)	
Exercise, moderate (day/week)	1.15±1.44	1.09±1.38	.673	1.09±1.50	1.12±1.51	.850

* Fisher's exact test

4. Discussion

According to the research of Park et al²⁷ using data of the 5th Korea National Health and Nutrition Examination Survey (KNHANES V) conducted in 2010, MetS

prevalence of adults was 16.8% in male and 20.7% in female. In this study, MetS was more prevalent in men (11.2%) than in women (1.8%). This could be thought that considering the increase of MetS in female after menopause, only younger than forties female subjects were

included in this study and the average age of the male was higher than female. Smoking and drinking prevalence in male was higher than female and therefore this could affect the prevalence. In Cheserek's research²⁸, MetS was shown higher in male workers than female workers and he mentioned gender specific health intervention is required to prevent CVD and Type 2 diabetes at the working place. Even though difference analysis was not executed in this study, it is necessary to identify risk factors which increase MetS in male subjects through multivariate analysis in the future.

Similar to the findings of Kelliny et al²⁹ and Choi³⁰ abdominal obesity or obesity was one of the components of the MetS that occurred frequently. The pattern of abnormality in MetS components was different for males and females. In the prevalence of abnormality of individual metabolic components, abdominal obesity or obesity, hypertriglyceridemia and hypertension were higher in males than females. Abdominal obesity or obesity in male workers reached 39.6%, so dietary therapy and exercise should be actively recommended for weight reduction. In female workers, there was highest low HDL-C along with adiposity. Because smoking and physical activity are could effect on HDL-C³¹, the further analysis through follow-up study is required. Seo³² thought MetS prevalence could be reduced by preferential management of risk factors which have prevalence in metabolic components. Therefore, customized management according to risk factors of male and female subjects could be effective to reduce MetS.

Occupational nurses have managed the blood glucose of workers by using simple blood glucose test in Korea. If the FBS measures 126 mg/dL or above, then an hemoglobin A1c (HbA1c) test is recommended for diagnosing of diabetes. And regular consulting and checkup are provided to control blood glucose until next health examination. The level of FBS was taken by a glucometer appeared to have more number of MetS components in the high FBS (≥ 126) group than in the normal FBS (< 126) group among male workers, even though prevalence of MetS did not show significant difference. This result show that simple blood glucose test by portable glucometer can be used for monitoring of blood glucose of workers. FBS values are measured using blood samples obtained from vein, not a capillary in this study. Therefore, it is suggested in future study to analyze with the obtained values using capillary blood which is gathered from the finger.

Among the living habits, smoking prevalence in men was higher in high FBS group than in normal FBS group and alcohol drinking prevalence in women was higher in high FBS group than in normal FBS group, but exercise in male and female subjects did not show significant differences between two groups. Because studies of the relationship between FBS level which is measured by glucometer with living habits could not be found, results in this study could not be directly compared. But looking at the researches which investigated the influences of smoking, drinking and exercise to fasting plasma glucose, Oh³³ mentioned in her research which investigated 6,281 male subjects older than 20 years old, past smokers or present smokers who smoke more than 10 packs of cigarettes a year showed higher blood glucose abnormality compared with non-smokers. In research of Lee et al³⁴ which investigated the relationship between male workers' health practice and hyperglycemia, the prevalence of hyperglycemia was 5 times higher in smokers than in non-smokers in older than 40 years old subjects, but there was no significant relationship in younger than 40 years old subjects, which could not completely support the result of this study.

Yoo et al³⁵ estimated the incidence and the degree of cigarette smoking and drinking among 2,287 working men, and then investigated the effects on blood pressure and blood chemistry. As a result, the smoking and drinking amount was not shown to be in the correlation with fasting blood sugar. However, in the research to analyze blood components in non-drinking group, healthy drinking group and alcoholism group, alcohol intake and blood glucose had positive dose-response relationship³⁶ and there were reports high consumption of alcohol³⁷ or daily alcohol intake³⁸ increased the risk of type 2 diabetes. In female workers of this study, high FBS group showed higher drinking prevalence than normal FBS group. The proportion of drinkers in Korean women is showing an increasing trend³⁹ and therefore, awareness about risk of drinking should be expanded.

According to the health behavior survey⁴⁰, the ratio of male smokers was highest at 54.8% in the age 30s, while the high risk drinking population among women accounted for 9.2% in the age 20s and 8.4% in the age 30s. These data indicate that twenties and thirties have bad living habits. As this study showed significant relationships between high level of blood glucose and smoking and drinking, continuous education and health management measures for the improvement of lifestyle habits of workers are required.

Different from the study results that physical activity affected the prevalence of MetS^{19,30} and regular exercise lowered blood glucose and improved MetS⁴¹, there was no significant relationship between exercise and blood glucose level in this study. This is because both male and female workers are doing exercise just one day per week and therefore, it would be difficult to identify the effect of exercise.

This study has a limitation to generalize the results because it dealt with the workers of only one company. So, further studies need to be designed using more representative sampling method to the population. Additionally, it is suggested prospective research about the relationship between continuous blood glucose management for the workers who have high FBS and MetS prevalence is required.

5. Conclusion

This study was carried out to investigate the relations between the prevalence of MetS and its components, living habits and Fasting Blood Sugar (FBS) level measured by glucometer in the working population under 40 years old.

As a result, prevalence of MetS was 11.2% in males and 1.8% in females. Regarding the association of FBS level with MetS and number of its components, there was significant increase in the number of MetS components in the high FBS (≥ 126) group when compared to normal FBS group in male workers. Regarding the association of FBS level with living habits, smoking in male workers and alcohol drinking in female workers were associated with high FBS.

These data imply that evaluation of FBS level by portable glucometer could be useful for predicting the presence of MetS. Therefore, it is suggested that the occupational health manager should actively use simple blood glucose test to prevent and manage MetS in workplace. It is also emphasized that consistent and effective nonsmoking and drinking moderation program should be conducted as a plan which could restrain the increase of blood sugar.

6. References

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