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Prevalence of Metabolic Syndrome and Its Predicting Factors among Small-sized Company Workers

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Purpose: This study was aimed to examine the prevalence of metabolic syndrome (MetS) and cardiovascular risk factors among workers at small-sized companies having fewer than 50employees in Korea. **Methods:** A descriptive cross-sectional study was conducted using a secondary data analysis on workers' health examination data.Data from 21,784 employed workers were analyzed, including 16,488 males (mean age 38.7years)and 5,296 females (mean age 40.5 years). Participants were newly enrolled in annual health check-ups at a professional health clinic from 2009 to 2011. Logistic regression analysis was performed to identify age-adjusted gender specific predicting factors of MetS incidence. **Results:** The prevalence of MetS was 13.4% in male and 7.7% in female workers. Logistic regression analysis showed that, when age was adjusted for, family history of cardiovascular disease (CVD) was a predicting factor in both male and female workers. For male workers, heavy alcohol drinking and non-manual occupation (office workers/drivers) predicted MetS. **Conclusion:** Health care providers should screen for MetS periodically in small work places especially for those with a family history of CVD. Educational counseling needs to be given to male workers with sedentary occupations with an aim to reduce heavy drinking and encourage lifestyle modification.

Key Words: Cardiovascular disease, Metabolic syndrome, Work environment, Health promotion

INTRODUCTION

Metabolic syndrome (MetS) is associated with insulin resistance and compensatory hyperinsulinemia and predicts a high risk for future development of type II diabetes and coronary artery disease (Boyko, de Courten, & Zimmet, 2000; Grundy, 2008; Klein, Klein, & Lee, 2002). MetS is a multiplex risk factor for atherosclerotic cardiovascular disease (CVD), and persons with MetS are reported to have twice the risk for CVD compared with those without MetS (Grundy, 2008; Grundy et al., 2005). In addition, the morbidity and mortality of CVD are higher in persons with MetS (Isomaa et al., 2001; Obunai, Jani, & Dangas, 2007). According to the Korea National Health Assessment Nutritional Examination Survey conducted between 2007 and 2010, the prevalence rate of MetS was 28.8% among adults over 30 years of age (Korea National Statistics Office, 2011). A recent meta-analysis including 43 cohort studies reported that individuals with MetS had 1.78 times more relative risk for CVD events and death, and CVD risk was still associated after controlling for traditional risk factors (Gami et al., 2007).

In Korea, deaths caused in the work field by CVD make up an estimated 50% of the total occupation-related deaths among workers. The Korean government spends about 9.5% of the total workers compensation on CVD management (Korea Occupational Safety and Health Agency [KOSHA], 2011). A study on 1,526 male employees found that the odds ratio of CVD in a MetS group was 5.6 times greater compared with a non-MetS group, thereby demonstrating a close relationship between a diagnosis of MetS and incidence of CVD (Yoon, Yi, Oh, & Lee, 2007). Therefore, MetS management is essential for CVD prevention in adult employees (Grundy, 2008; Kim, Park, Park, Kim, & Moon, 2009).

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In South Korea, occupational health promotion by health care providers in charge of workers' health management has tended to be less focused on small companies (i.e., those having 300 or fewer employees) than on large companies (Kim & Kang, 2010; Korea Ministry Employment and Labor, 2013).Small workplaces with fewer than 50 employees make up 97.7% of the total number of companies in South Korea, and the number of workers in companies with fewer than 50 employees accounted for 82.3% of the total company employees. According to the KOSHA (2011), the incidence rate of CVD was about 68% of employees in small-sized companies or industries, and the mortality rate of CVD was ranked 2nd among occupation-related deaths. In particular, CVD occurred in 32.0% of companies with more than 50 employees and in 68.0% of small companies in 2011 (KOSHA, 2011).

Employees working in small companies are vulnerable to unhealthy lifestyle factors (Hwang& Hong, 2012; Kanjilal et al., 2006) and have low CVD risk perception (Hwang, Hong, & Kim, 2012)than workers in large-sized companies.In addition, lifestyle risk factors influencing on the prevalence of MetS and CVD might be differed by gender and age group. That suggests, for CVD prevention, a need for systematic health management for small company workers and it should be gender and age group specific (Hwang& Hong, 2012). Therefore, by using health screening data on employees of small companies, this study aims to (a) identify the prevalence rates of MetS and its components, (b) identify the prevalence of combinations of CVD risk factors by gender and age group, and (c) examine the predicting factors of MetS by gender.

METHODS

1. Design and Sample

This is a cross-sectional descriptive study using a secondary data analysis on routine health screening data of workers employed at small companies.

2. Data Collection

Data from workers who had taken an annual health screening as part of a general or special health examination for the first time between 2009 and 2011were primarily obtained at the industrial health center of K hospital in G city. The data were extracted from 21,784 workers in about 1,150 small companies or industries having 50 or fewer employees where located at G city or J province in South Korea. Before commencing this study, we obtained written approval from the director of the health care center and the head of K hospital for the use of the data after explaining the purpose of the study. Collected health data were clarified and coded for statistical analysis by the second author of this study, who is currently working as a nurseat the health center. This research protocol was approved by the Institutional Review Board of the University (IRB-12-012)whom which the principal investigator is affiliated, and this study was one of two research objectives proposed for using the data.

3. Measures

Subjects' health screening data included the items related to this study's objectives: sex, age, workplace, height, weight, body mass index (BMI), abdominal circumference, previous and current medical history, family history of CVD, blood pressure, blood test results (total cholesterol, high-density lipid cholesterol, fasting blood sugar, triglycerides), and the items for lifestyle habits (smoking, physical exercise, alcohol consumption). Smoking status was divided into three categories: nonsmoker, ex-smoker, and current smoker. For physical exercise, subjects were asked about whether they exercised at an intensity of reaching a slight difficulty in breathing and sweating, and status was categorized based on the regularity, frequency, and length of time. Alcohol consumption was assessed through questions about drinking behavior during the week prior to the survey and was then categorized into non/light and heavy ($\geq$3 times/week with 30 g/day for men and 15 g/day for women) based on average frequency and daily amount. Occupation was categorized as manual workers, including manufacturers, mechanics, auto mechanics, wood cutters, metal platers, pressers, electricians, and service workers; and non-manual workers, including office workers and drivers.

The prevalence of MetS was calculated using the diagnostic criteria proposed by the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III, 2002). An individual can be diagnosed with MetS if they meet three or more of the following five NCEP-ATP III diagnostic criteria: 1. Abdominal obesity: waist circumference for men 90 cm, women $\geq$80 cm; 2. Hypertension:$\geq$130/85 mmHg or diagnosed with hypertension; 3. Hypertriglyceridemia: triglycerides $\geq$50 mg/dL; 4. High blood sugar: fasting blood glucose $\geq$110 mg/dL or diagnosed with diabetes; 5. Low HDL cholesterol: men $<$40 mg/dL, women $<$50 mg/dL.

4. Analytic strategy

All statistical analysis was performed using SPSS/WIN 21.0. Descriptive statistics were used to describe the characteristics, health behaviors, and prevalence of components of MetS. Independent student t-tests and x^2-tests were used to examine the relationships between characteristics of MetS and non-MetS among male and female workers. Multiple logistic regression analysis was performed to determine which variables predicted the prevalence of MetS by gender.

RESULTS

1. Sample Characteristics

Male subjects made up 75.7% of the sample, and female subjects 24.3%. The mean age was 38.7±10.6 years for male subjects and 40.5±11.0 years for female subjects (range: 20~70 years). According to occupation, a majority of male and female subjects (86.7%)were manual workers, and 9.7% of the male subjects were bus or taxi drivers. Of the male and female subjects combined, 5.5% reported that they had hypertension, and 1.9% and 1.2% had diabetes, respectively. Further, 50.3% ofmale subjects were current smokers, 16.7% drank over three times per week (≥30 g/day), and 79% did physical exercise less than twice per week. On the other hand, 8.3% of female subjects were current smokers, 5.9% drank heavily over three times per week (≥15 g/day), and 86% did physical exercise less than twice per week (Table 1).

2. Prevalence of MetS and Lifestyle Factors among Study Sample

The prevalence of MetS was 13.4% for male subjects and 7.7% for female subjects. The five components (i.e., diagnostic criteria) of MetS by gender are presented in Table 2. Among all subjects, distributions of MetS and the number of components and unhealthy lifestyle factors (current smoking, heavy alcohol drinking, and physical inactivity) by age group are presented in Figure 1.

Table 1. Demographic Characteristics of the Subjects (*N*=21,784)

Characteristics	Categories	Male workers (n=16,488)	Female workers (n=5,296)	x^2 or t	*p*
		n (%) or M±SD	n (%) or M±SD		
Age (year)	20~39	9,696 (58.8)	2,432 (45.9)	269.67	<.001
	40~70	6,792 (41.2)	2,864 (54.1)		
		38.69±10.58	40.51±11.01		
Occupation	Manual worker	14,288 (86.7)	4,546 (85.8)	1,105.69	<.001
	Office worker	596 (3.6)	719 (13.6)		
	Driver (bus/taxi)	1,604 (9.7)	31 (0.6)		
Medical history (multiple answers)	Stroke	24 (0.1)	4 (0.1)	1.53	.216
	Heart disease	99 (0.6)	15 (0.3)	7.74	.005
	Hypertension	913 (5.5)	290 (5.5)	0.02	.865
	Diabetes	319 (1.9)	66 (1.2)	10.94	.001
Family history (multiple answers)	Stroke	335 (2.0)	108 (2.0)	0.00	.973
	Heart disease	386 (2.3)	133 (2.5)	0.49	.470
	Hypertension	1,177 (7.1)	470 (8.9)	17.28	<.001
	Diabetes	1,433 (8.7)	537 (10.1)	10.22	.001
Smoking	Non-smokers	5,628 (34.1)	4,682 (88.4)	4,738.27	<.001
	Ex-smokers	2,563 (15.5)	174 (3.3)		
	Current smokers	8,297 (50.3)	440 (8.3)		
Alcohol drinking	None	5,457 (33.1)	3,229 (61.0)	1,371.99	<.001
	Light	8,263 (50.1)	1,753 (33.1)		
	Heavy†	2,768 (16.7)	314 (5.9)		
Physical exercise	None	4,156 (25.2)	1,685 (31.8)	166.58	<.001
	1~2 times/week	8,867 (53.8)	2,865 (54.1)		
	≥3~4 times/week	3,465 (21.0)	746 (14.0)		

† Drinkers who had more than 3 times per a week with 30 g/day for men and 15 g/day for women.

Table 2. Prevalence of Metabolic Syndrome and its Components among Subjects (*N*=21,784)

Variables	Male (n =16,488)	Female (n=5,296)
	n (%)	n (%)
Metabolic syndrome	2216 (13.4)	406 (7.7)
Waist circumference (men ≥ 90 cm, women ≥ 80 cm)	1587 (9.6)	643 (12.1)
Hypertension (≥ 130/85 mmHg) †	3281 (19.9)	750 (14.2)
Triglyceride (≥ 150 mg/dL)	6761 (41.0)	882 (16.7)
HDL-cholesterol (men < 40, women < 50 mg/dL)	1896 (11.5)	943 (17.8)
Fasting blood glucose (> 110 mg/dL) †	2095 (12.7)	429 (8.1)

HDL=high density lipoprotein.
† Included the number of diagnosed patients who are taking medication.

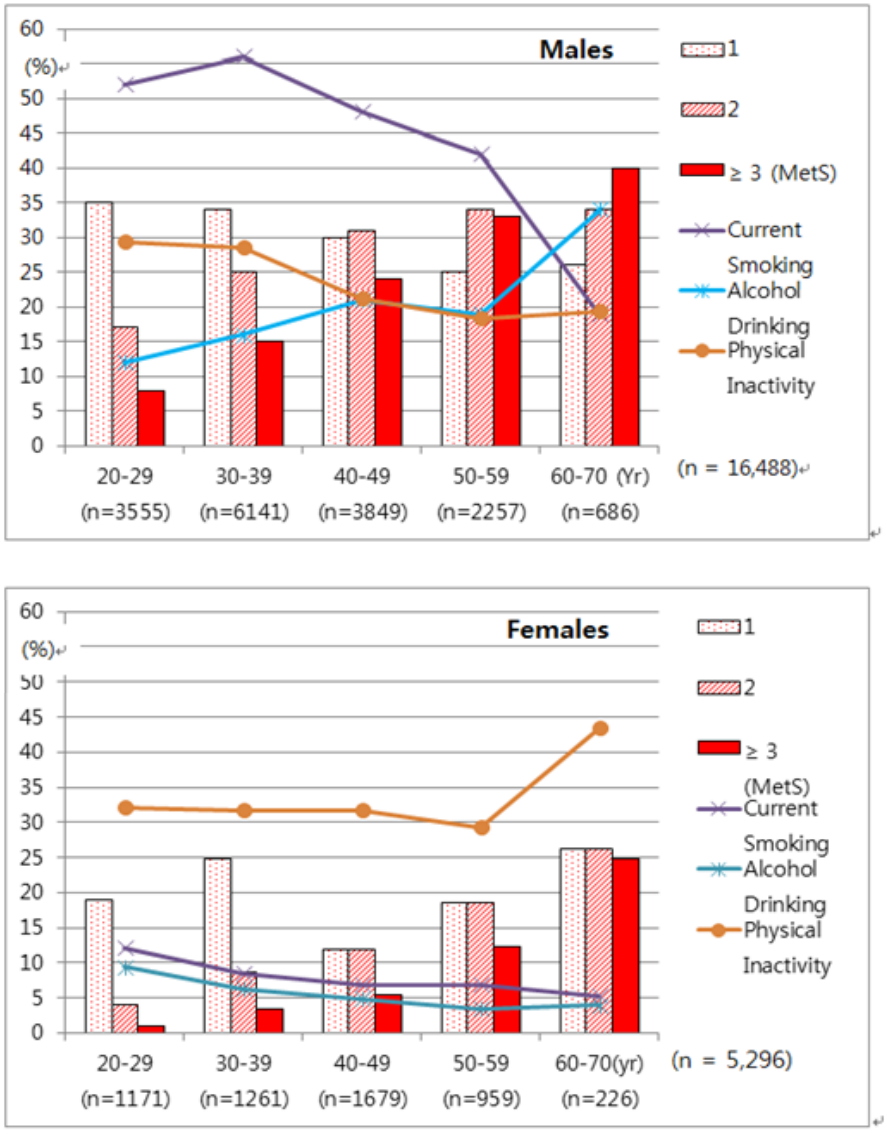

Figure 1. Distributions of MetS and the number of components and unhealthy lifestyle behaviors by age group among male and female subjects

3. Relationship between Subjects' Characteristics and MetS by Gender

With respect to male and female subjects, the group with MetS was more likely to be over 40 years old and manual workers than the group without MetS ($p<.001$). The male subjects with CVD family histories including stroke, heart disease, hypertension, or diabetes were more likely to have MetS ($p<.001$). In the same vein, the female subjects with family histories of stroke and hypertension were more likely to have MetS. In addition, the male subjects who were heavily drinking more than three times/week ($p<.001$) and had less exercise (<1~2 times/week)were more likely to have MetS compared with their counterparts. In female subjects, heavy drinking was significantly related to the prevalence of MetS (Table 3).

4. Predicting Factors for MetS in Male and Female Subjects

Among male subjects, adjusted for age, non-manual workers were1.17 times more likely to have MetS thanmanual workers (odds ratio [OR] 1.17, 95% confidence interval [CI] 1.04~1.32, $p=.011$), and workers who drank alcohol heavily more than three times per week were 1.54 times more likely to have MetS than were their counterparts (OR 1.54, 95% CI 1.38~1.72, $p<.001$). Male and female subjects who had a family history of CVD risk factors were 1.75 and 1.94 times more likely to have MetS, respectively (OR 1.75, 95% CI 1.53~2.01; OR 1.94, 95% CI 1.46~2.53, $p<.001$)than were those with no family history. The results of the multivariate logistic regression analysis are shown in Table 4.

DISCUSSION

According to the diagnosis criteria proposed by the NCEP-ATPIII, the prevalence of MetS in this study was 13.4% in male workers and 7.7% in female workers. This rateis comparable to studies of male workers that reported MetS prevalence as 15% in 1,198 Korean shipyard workers (Kim et al., 2009), 13.3% in Japanese, 14.2% in Korean (Shiwaku et al., 2005), and 11.6% in Spanish (Sanchez-Chaparro et al., 2008). With regard to female workers, the prevalence rate was a little higher than the 4.1% in Spanish female workers (Sanchez-Chaparro et al., 2008). However, the MetS prevalence rate in this study was lower than in studies that examined representative KNHANES samples in 2005 and reported 27.2% in men and 24.7% in women (Kim & Kim, 2011). In addition, it was lower than 20.2% for American male employees and 21.4% for female employees (Davila et al., 2010). This discrepancy might be due to differences inoccupation and age of study samples, as our study targeted small company or industry workers, and 56% of the total subjects were younger than 40 years old (which was younger than in other studies). In addition,

Table 3. Relationship Subjects' Characteristics and Metabolic Syndrome vs Not Having MetS by Gender (*N*=21,784)

Variables	Categories	Male with MetS (n=2,216)		Female with MetS (n=406)	
		n (%)	x^2	n (%)	x^2
Age(year)	20~39 40~70	789 (36.0) 1,418 (64.0)	549.16**	54 (13.3) 352 (86.7)	212.87**
Occupation	Manual Office/driver	1,781 (80.4) 435 (19.6)	87.51**	373 (91.9) 33 (8.1)	15.03**
Family CVD history †	Yes (>1) No	317 (14.3) 1,899 (85.7)	79.13**	76 (18.7) 330 (81.3)	26.68**
Smoking	Non/ex-smoker Current smoker	1,123 (50.7) 1,093 (49.3)	1.02	374 (92.1) 32 (7.9)	0.10
Alcohol drinking	Heavy None/light	604 (27.3) 1,612 (72.7)	39.43**	272 (67.0) 134 (33.0)	6.84*
Physical exercise	None ≥1~2 times/week	487 (22.0) 1,729 (78.0)	14.16**	119 (29.3) 287 (70.7)	1.25

CVD=cardiovascular disease.
† Family CVD history includes hypertension, diabetes, stroke, or coronary artery disease.
*$p<.01$ ** $p<.001$.

Table 4. Predicting Factors of Metabolic Syndrome by Gender (*N*=21,784)

Variables	Categories	Male with MetS (n=2,216) Adjusted OR (95% CI)	*p*	Female with MetS (n=406) Adjusted OR (95% CI)	*p*
Age (year)	20~39	1		1	
	≥40	2.76 (2.50~3.04)	<.001	5.98 (4.36~7.97)	<.001
Occupation	Manual	1		1	
	Office/driver	1.17 (1.03~1.32)	.011	0.75 (0.51~1.10)	.153
Family history †	No	1		1	
	Yes	1.75 (1.53~2.01)	<.001	1.94 (1.46~2.53)	<.001
Smoking	Non/previous	1		1	
	Current	1.01 (0.92~1.11)	.819	1.13 (0.75~1.69)	.539
Alcohol drinking	Non/light	1		1	
	Heavy	1.54 (1.38~1.72)	<.001	0.86 (0.51~1.45)	.581
Physical exercise	≥1~2 times/week	1		1	
	None	0.95 (0.85~1.07)	.438	0.92 (0.73~1.16)	.500

† Family history of cardiovascular disease included hypertension, diabetes, heart disease, and stroke.

the difference might be due to use of different criteria for MetS to measure obesity; our study used abdominal circumference, but other study used a BMI tailored to the characteristics of Asian people (Shiwaku et al., 2005).

As for the components of MetS, male subjects had the highest prevalence of hypertriglyceridemia (41%), followed by hypertension (20%) and hyperglycemia (12%). The prevalence rates for hypertriglyceridemia and hyperglycemia were higher than 32.2% and 5.2% in Korean male shipyard workers, respectively (Kim et al., 2009). However, hypertension had lower occurrence in this study sample compared to in which hypertension occurred in 31.7% of the shipyard workers.

A multivariate logistic regression analysis revealed that, after controlling for age, a family history of CVD was the most important independent predictor of MetS in both male and female subjects. The family history of CVD included hypertension, diabetes, stroke, or coronary artery disease in this study. The male and female subjects with family CVD history were 1.75 and 1.94 times more likely to have MetS, respectively. This finding is consistent with the results of previous studies that a family history of CVD was significantly associated with 1.4~1.5 times more increased likelihood of having MetS in a mixed ethnic-population (Dunkley, Taub, Davies, Stone, & Khunti, 2009) and Korean (Lee, Jung, Park, Rhee, & Kim, 2005). Therefore, health care providers or nurses should screen periodically for MetS when conducting health counseling, in order to prevent early further CVD events among workers with a family history of CVD.

Occupation type was found to be the second most important independent predictor of MetS for male subjects in this study, suggesting that occupation is closely related to the prevalence of MetS. Office workers and bus or taxi drivers in this study had a greater chance of having MetS compared with manual workers, likely because of their sedentary lifestyle. This is consistent with the results of another study showing a higher prevalence of MetS among that office workers (19.6%) compared with 14% of productive workers (Kim et al., 2009). In addition, the fact that MetS is more prevalent in non-manual workers than in manual workers due to sedentary lifestyle is supported by a previous national study in Korea (Myong, Kim, Jung-Choi, Baker, & Choi, 2012).

Heavy alcohol consumption turned out to be an independent predictor of MetS in male subjects; the workers who drank alcohol heavily were 1.5 times more likely to have MetS. This finding is consistent with in which the workers who drank alcohol had a 1.8-fold higher prevalence of MetS than did workers who did not drink. This is also similar to a national study on the Korean general population, which showed that heavy alcohol consumption was associated significantly with higher blood pressure and triacylglycerol in men. In addition, the ORs of MetS and its components tended to increase with increasing alcohol consumption (Yoon et al., 2004).In this study, 16.7% of total male subjects (n= 2,768) and 27.3% of male subjects with MetS (n=604) drank heavily (i.e., more than three times per week). From the perspective of Korean culture, many Korean male workers frequentlydine and drink with company colleagues in the

evening. Especially among employed workers, low individual coping skills with chronic emotional stress and organizational environmental stress can encourage them to be heavy drinkers, thereby increasing the risk of CVD (Hwang et al., 2007; Jekarl, Kim, & Lee, 2010). Furthermore, 41.0% of male subjects in this study showed a high serum triglyceride level (≥150 mg/dL). Hypertriglyceridemia is the most frequent and earliest alteration associated with MetS, due to the increase in the hepatic synthesis of very-low density lipoprotein (Real et al., 2006) characteristic of the disease, and it can be used as a marker for the screening of metabolic and cardiovascular alterations (Ascaso et al., 2011). It was also found to be an important influencing factor in the diagnosis of MetS and CVD risk index (Yoon et al., 2007), especially in Korean workers compared with Japanese and Mongolians (Shiwaku et al., 2005). Accordingly, further research is needed to find ways of reducing CVD risk through early screening and intervention for heavy drinking workers with hypertriglyceridemia.

In this study, smoking and physical exercise were not supported as influencing factors in MetS. This result is inconsistent with many previous studies on workers, which reported that current smoking (Bamia, Trichopoulos, Lenas, & Trichopoulos, 2004; Kim et al., 2009; Park, Oh, Cho, Choi, & Kim, 2004) and lack of physical exercise (Kim et al., 2009) were factors in higher prevalence of MetS. However, 50.3% of male subjects in this study and 49.3% of those with MetS were current smokers; this suggests that smoking habits among male workers need to be managed to prevent the development of MetS and CVD in Korea. Numerous studies have attempted to explain that lifestyle habits can affect MetS risk factors and that a healthy lifestyle can delay or prevent the incidence of MetS (Azadbakht, Mirmiran, Esmaillzadeh, Azizi,& Azizi, 2005; Giugliano, Ceriello, & Esposito, 2006). Although the prevalence of MetS increased with age in this study, it would be important to address unhealthy lifestyle factors, especially for younger workers aged 20~39, because about 50% and 30% were current smokers and physically inactive, respectively. These young workers may become heavy drinkers in their forties and fifties. reported that the markers of MetS and health cost were significantly reduced in the intervention group with health promotion education at a 12-month follow-up. Therefore, individual health monitoring and counseling by industrial nurses, which recently has been adopted for small industries, should be continued for young workers with unhealthy lifestyle habits to prevent MetS and reduce CVD risk. In addition, a prospective study is needed to examine the effects of occupational nurses' counseling on the health status and lifestyle changes of the workers.

This study was a first attempt and offers information to health care providers using large-scale health examination data from small company workers in Korea about the risk of CVD and prevalence of MetS in this population. However, this study has a several limitations. First, this study was based on a cross-sectional sample using health examination data of workers in a particular area. Thus, we are not able to generalize the study results to all small company workers in Korea and could not assess the causal relationship between demographic characteristics and MetS components. Second, we did not obtain data on education and income level, and only used occupation type to determine whether socioeconomic status influenced the prevalence of MetS. Hwang & Hong (2012) suggested that work-related environmental and psychosocial factors need to be incorporated for assessment of the workers' CVD risks and intervention plan. Accordingly, further study is needed to examine the factors influencing MetS, including a more comprehensive set of socioeconomic variables surrounding workers. Finally, the assessment of lifestyle habits depended on self-report, and recall bias might have existed.

CONCLUSION

According to the diagnosis criteria proposed by NCEP-ATPIII, the prevalence of MetS was 13.4% in male subjects and 7.7% in female subjects who were working at small-sized companies. When age was controlled for, family history of CVD risk factors was found to be the strongest predicting factor for the prevalence of MetS among both male and female workers. For male workers, heavy alcohol drinking was found to be a significant predictor of the prevalence of MetS. More preventive attention is needed for workers at small-sized companies where there is no obligation to employ a healthcare manager. Early interventions are needed for workers with family history of CVD, especially for male workers who had heavy alcohol consumption and engaged in sedentary occupations in order to prevent MetS and further CVD occurrence.

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