Journal
Industrial health, 50(2)

ISSN
1880-8026

Authors
Myong, Jun-Pyo
Kim, Hyoung-Ryoul
Jung-Choi, Kyunghee
et al.

Publication Date
2012-02-01

Industrial Health 2012, **50**, 115–122

Original Article

Disparities of Metabolic Syndrome Prevalence by Age, Gender and Occupation among Korean Adult Workers

Jun-Pyo MYONG[1], Hyoung-Ryoul KIM[1]*, Kyunghee JUNG-CHOI[2], Dean BAKER[3] and BongKyoo CHOI[3]

[1] Department. of Occupational and Environmental Medicine, Catholic Industrial Medical Center, The Catholic University of Korea, College of Medicine, 505 BanPo-dong Seocho-gu, Seoul 137-701, Republic of Korea
[2] Departmentof Preventive Medicine, Ewha Womens University School of Medicine, Seoul, Republic of Korea
[3] Center for Occupational and Environmental Health, University of California, Irvine, USA

Received October 7, 2011 and accepted December 26, 2011
Published online in J-STAGE February 1, 2012

Abstract: Occupation can influence the prevalence of metabolic syndrome. Age and gender could interact with the association between occupation and metabolic syndrome. This study aimed to investigate the prevalence of metabolic syndrome among the Korean working population and determine whether the prevalence differed according to occupation, age and gender. We conducted a cross-sectional study in Korean adults using the Third Korean National Health and Nutrition Examination Survey (KNHANES III). The analysis included 3,288 workers over 19 yr old. The prevalence odds ratios (PORs) of metabolic syndrome among representative types of occupations were estimated after stratification for age and gender by logistic regression. Female manual workers had a higher prevalence of metabolic syndrome than female non-manual workers among those younger than age 50 (POR=1.95, 95%CI=1.12–3.40). However, female manual workers aged 50 and older had a lower prevalence of metabolic syndrome than female non-manual workers (POR=0.36, 95%CI=0.22–0.59). Manual occupations can be a risk factor for metabolic syndrome, but this correlation is limited to younger female workers. The effects of occupation on the prevalence of metabolic syndrome were different between older and younger workers, which could be due to longitudinal transition of socio-cultural structure.

Key words: Metabolic syndrome, Manual workers, Interaction, Korean workers, Socio-cultural structure

Introduction

The prevalence of cardiovascular disease (CVD) has increased rapidly in Asian countries because of an increasingly westernized lifestyle characterized by excess consumption of calories and physical inactivity[1, 2]. In Korea, the rate of CVD-related mortality was 115 per 100,000 in 2005 and 117 per 100,000 in 2007, and CVD is the second leading cause of death after cancer in Korea[3]. The factors associated with increased risk of developing CVD tend to cluster in personal biological traits including high blood pressure, high fasting glucose, high triglyceride level, low plasma high-density lipoprotein cholesterol level, and abdominal obesity. These clustered factors have been called the metabolic syndrome and it is well established that metabolic syndrome is associated with CVD[4]. The

*To whom correspondence should be addressed.
E-mail: cyclor@catholic.ac.kr

overall prevalence of the metabolic syndrome is about 25% in general populations from the United States (US) and Europe[5–7]. In Korea, 31% of men and 27.6% of women have the metabolic syndrome in nationally representative samples[8]. Considering that the findings from the third National Health and Nutrition Examination Survey showed 24% of men and 23.7% of women in the US have metabolic syndrome[9], Korean people's prevalence of the metabolic syndrome is much higher than one may expect. There is little information about the prevalence of metabolic syndrome or its risk factors in workers. Occupation can reflect physical activity in workplace; it is also an indicator of social economic position[10]. Some studies have shown different associations between SEP (social economic position) and the prevalence of the metabolic syndrome by gender[6–8]. In addition, we should consider the different patterns among old and young generation group in countries which have experienced rapid socio-cultural changes. This study aimed to investigate the prevalence of metabolic syndrome among a Korean working population and determine whether the prevalence differed according to occupation, age and gender. We conducted a cross-sectional study in Korean adult workers who participated in the Third Korean National Health and Nutrition Examination Survey (KNHANES III).

Subjects and Methods

Subjects

This study was based on the KNHANES III. Health interviews and examinations were performed in 2005. A stratified multistage clustered probability design was used to select representative samples of noninstitutionalized Korean civilians for the survey. Trained interviewers visited the subjects in their homes and administered a standardized health examination and questionnaire. To evaluate the association between metabolic syndrome and the work tasks of different occupational groups, subjects who had no job, housewives and those 19 yr old or less were excluded from this study. Finally, 3,288 adults (1,508 manual workers and 1,780 nonmanual workers) with defined jobs were included in this study. According to "Act on Age Discrimination Prohibition in Employment and Aged Employment Promotion" in Korea, the aged is defined as 55 and over 55 and the semi-aged is defined as 50 and over 50, but less than 55. So, we defined old workers as 50 and over 50 and young workers as less than 50. This study was approved by the Institutional Review Board of the Catholic University of Korea, College of Medicine (CUMC10U186).

Classification of occupation

The occupational classification followed the major groups of the Korean Standard Classification of Occupations (KSCO). The subjects were classified into nonmanual and manual worker groups. Nonmanual work included the managers, professions, technicians, sales and service workers and clerical work. Manual work included agriculture, forestry, fishery (unskilled), manufacturing, construction, mining and the armed forces.

Definition of metabolic syndrome and clinical status

According to the definition of the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III)[11], a person who has three or more of the following risk factors is defined as having metabolic syndrome: triglyceride level ≥ 150 mg/dl or specific treatment for lipid abnormality; HDL cholesterol level < 40 mg/dl in men, <50 mg/dl in women; systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg or treated or previously diagnosed hypertension; fasting plasma glucose level ≥ 110 mg/dl or treated or previously diagnosed diabetes; and abdominal obesity. For the definition of abdominal obesity, it must be considered that Asians may have a different body fat distribution than the Western population[12]. The World Health Organization suggests a waist circumference ≥ 90 cm for men and ≥ 80 cm for women in Asians as defining abdominal obesity[12, 13], and the KNHANES III used these criteria. Waist circumference was measured at the end of a normal expiration, with the arms relaxed at the sides, from narrowest point between the top of the hip and the lower part of the last rib.

Blood pressure was measured with a mercury sphygmomanometer in the seated position after 10 minutes rest, and three measurements were performed on subjects at five-minute intervals. The first measurement was discarded and the next two were used for determining the average blood pressure. Blood samples for fasting blood glucose (FBS), HDL-cholesterol, triglyceride (TG) were taken by skilled practitioners in the morning after overnight fasting (longer than 10 h) and plasma was separated by centrifugation immediately. An Advia 1650/2400 (Siemens, New York, NY) was used for blood sample analyses in the KNHANES III.

Definition of health behaviors

Subjects were classified as current, ex-, and non-smokers. Those who were smokers at the examination were defined as current smokers, those who smoked in the past but no longer smoked as ex-smokers, and those who never smoked as non-smokers. Alcohol consumption was estimated from the daily alcohol intake based on a published guideline[14]. Trained interviewers asked the subjects about the frequency and amount of their alcohol ingestion and this was converted into the amount of pure alcohol intake per day. Those who ingested over 15 (female) or 30 (male) g/day of alcohol were defined as being in the alcohol intake group. For optimal physical activity was defined as 'moderate exercise such as brisk walking, bicycling, water aerobics, and etc. 30 min or over' and divided into two groups; 5 or more times per week and less than 5 times.

Statistical analysis

Statistical analyses were performed using SAS 9.1. Sampling weights were used to take the complex sampling design into account. The subjects were evaluated by statistical methods to provide representative data for estimating the prevalence of metabolic syndrome. SAS survey procedures were used to estimate the mean and standard error (SE) of continuous variables. SAS survey frequency procedure and Rao–Scott chi-square analysis were used to compare the prevalence of categorical variables by occupational status expressed as percentages and SEs. Logistic regression analyses were used to estimate the prevalence odds ratios (PORs) of metabolic syndrome in different occupational status adjusted for age, after stratification for age and gender. The multiple logistic regression analyses were repeated after adjustment for age, smoking, alcohol consumption, and physical activity.

Results

The general characteristics of the Korean adult working population based on KNHANES are shown in Table 1. Manual workers were more likely to be older than nonmanual workers. The BMI and waist circumference of female nonmanual workers were lower than those of manual workers, but the reverse was true for males. Nonmanual workers had better values for the health parameters of systolic/diastolic blood pressure and fasting glucose. The rate of current smokers was higher in manual workers, but the rate of moderate drinking was higher in nonmanual workers.

Table 2 presents the estimated prevalence of metabolic syndrome and its components in the male adult working population stratified by age. The prevalence of metabolic syndrome among old male nonmanual workers was 43.3%, which is significantly higher than that of manual workers in the same age group (31.9%).

Table 3 shows that, in young females workers, the prevalence of metabolic syndrome was higher in manual workers than in nonmanual workers, but the reverse was observed in old female workers. For young females workers, the prevalences of individual components of metabolic syndrome (waist circumference and the incidence of hypertension, impaired fasting glucose and high triglyceride levels) were significantly higher in manual workers, while the reverse pattern was observed among the older females with waist circumference and hgh triglycerides being significantly higher in nonmanual workers.

Figure 1 presents the PORs for metabolic syndrome according to occupational status by age. With each increasing age category, manual workers were less likely to have metabolic syndrome than nonmanual workers. Nonmanual workers had more risk for metabolic syndrome than manual workers in old workers, while manual workers were more likely to be with metabolic syndrome than nonmanual workers in young workers.

Table 4 shows the PORs that measure the relative level of risk for metabolic syndrome in the two occupational groups stratified by gender and age. Model I was derived from logistic regression models after adjustment for age. Among young female workers, there was a significantly higher prevalence of metabolic syndrome in manual workers than in nonmanual workers (POR=1.96, 95%CI; 1.12–3.45), whereas the prevalence was higher in old female nonmanual workers (POR=0.37, 95%CI; 0.23–0.60). Similar effects were found after adjustment for smoking, alcohol, and exercise (Model II). In male workers, similar patterns were found according to age, but, they were not statistically significant.

Discussion

According to research on the prevalence of metabolic syndrome in US workers, the overall prevalence for all workers was 20.6% (20.2% in male, and 21.4% in female)[15]. In Spanish workers, the prevalence of the metabolic syndrome was 9.5% (11.6% in male, and 4.1% in female)[10]. In this survey using the Korean working group, the prevalence was 21.8% (25.5% and 15.9%, in male and female, respectively). This prevalence is considered to be high compared to those of western countries. The prevalence of metabolic syndrome in manual workers was higher than those in nonmanual workers among both male and female in this study. And the difference of prevalence between manual and nonmanual workers was bigger in female workers. These results were consistent with those in the Spanish working group; manual work was

Table 1. General characteristics and metabolic syndrome prevalence of the Korean adult working population by type of work and gender

	Male			
	Nonmanual [891/7,002,293]	Manual [916/6,508,795]	Total [1,807/13,511,088]	*p*-value
Age (yr)	39.4 (0.5)	44.6 (0.6)	41.9 (0.4)	<0.01
Weight (kg)	71.4 (0.4)	68.2 (0.5)	69.9 (0.3)	<0.01
Height (cm)	171.4 (0.3)	168.6 (0.3)	170.0 (0.2)	<0.01
BMI	24.3 (0.1)	23.9 (0.1)	24.1 (0.1)	0.11
Waist circumference (cm)	84.5 (0.3)	83.3 (0.4)	83.9 (0.3)	<0.05
Systolic blood pressure (mmHg)	118.4 (0.5)	122.3 (0.6)	120.3 (0.4)	<0.01
Diastolic blood pressure (mmHg)	80.0 (0.5)	81.1 (0.5)	80.5 (0.4)	0.06
Fasting glucose (mg/dl)	94.7 (0.7)	96.3 (0.7)	95.5 (0.5)	0.10
HDL (mg/dl)†	39.5 (35.0–46.0)	41.0 (36.0–49.0)	40.0 (35.0–47.0)	<0.01
Triglycerides (mg/dl)†	133.0 (93.0–193.0)	122.0 (85.0–189.0)	126.0 (89.0–192.0)	0.90
Current smoker*	78.3 (1.6)	81.0 (1.8)	79.6 (1.2)	<0.05
Ex-smoker*	2.9 (0.6)	3.2 (0.9)	3.0 (0.5)	
Non-smoker*	18.8 (1.5)	15.9 (1.6)	17.4 (1.1)	
Alcohol consumption (≥ moderate)*	58.6 (1.6)	55.5 (1.5)	57.1 (1.6)	0.29
Optimal physical activity (yes)*	16.5 (1.7)	23.1 (2.1)	19.7 (1.5)	<0.01
Metabolic syndrome prevalence*	24.2 (1.6)	26.8 (1.2)	25.5 (1.2)	0.28
	Female			
	Nonmanual [889/5,471,666]	Manual [592/2,800,246]	Total [1,481/8,271,912]	*p*-value
Age (yr)	37.1 (0.5)	49.7 (0.6)	41.4 (0.5)	<0.01
Weight (kg)	57.1 (0.4)	58.1 (0.5)	57.4 (0.3)	0.12
Height (cm)	158.8 (0.2)	155.0 (0.3)	157.5 (0.2)	<0.01
BMI	22.7 (0.1)	24.1 (0.2)	23.2 (0.1)	<0.01
Waist circumference (cm)	75.3 (0.4)	80.0 (0.5)	76.9 (0.4)	<0.01
Systolic blood pressure (mmHg)	109.3 (0.7)	118.4 (1.0)	112.4 (0.6)	<0.01
Diastolic blood pressure (mmHg)	72.2 (0.5)	75.9 (0.5)	73.5 (0.4)	<0.01
Fasting glucose (mg/dl)	88.2 (0.5)	94.8 (1.1)	90.5 (0.5)	<0.01
HDL (mg/dl)†	47.0 (41.0–55.0)	45.0 (40.0–53.0)	46.0 (40.0–54.0)	<0.01
Triglycerides (mg/dl)†	83.0 (62.0–118.0)	93.0 (69.0–130.0)	87.0 (64.5–124.0)	<0.01
Current smoker*	7.2 (1.1)	7.3 (1.5)	7.2 (0.9)	0.57
Ex-smoker*	1.5 (0.4)	0.7 (0.3)	1.3 (0.3)	
Non-smoker*	91.3 (1.2)	91.9 (1.6)	91.5 (0.9)	
Alcohol consumption (≥ moderate)*	21.1 (1.1)	14.2 (0.7)	18.8 (1.2)	<0.01
Optimal physical activity (yes)*	21.7 (1.9)	25.0 (2.8)	22.8 (1.7)	0.29
Metabolic syndrome prevalence*	12.0 (1.3)	23.4 (2.1)	15.9 (1.2)	<0.01

[Sample number/Total estimated Korean workers], all values were weighted mean and standard error unless otherwise stated. *:estimated percentage (standard error). †: median and 25th–75th.

vulnerable to a metabolic syndrome, and the difference of prevalence between manual and nonmanual workers was more prominent in female (4.7% vs. 7.4%)[10]. However, interestingly, very distinctive results appeared in our study, after stratification by age and gender. Manual workers seemed to have risk of metabolic syndrome differently according to age and gender. We observed female manual workers were more likely to have metabolic syndrome in young workers (POR: 1.95 [1.12–3.40]), but vice versa in old workers (0.36 [0.22–0.59]). These results suggest that there may be interactions of age in the association between occupation and metabolic syndrome in female workers. Although it is not significant statistically, the different associations according to age also appeared in men workers

Table 2. Estimated prevalence of metabolic syndrome and its components in the Korean male adult working population by type of work and age

	< 50				≥ 50			
	Nonmanual [699/5,876,394]	Manual [490/4,320,931]	Total [1,189/10,197,326]	*p*-value	Nonmanual [192/1,125,899]	Manual [426/2,187,863]	Total [618/3,313,763]	*p*-value
Metabolic syndrome components*								
≥ 3	19.3 (1.0)	22.3 (1.1)	20.6 (1.4)	0.2837	43.3 (1.7)	31.9 (1.8)	35.8 (2.3)	0.0106
≥ 2	41.1 (1.6)	44.5 (1.3)	42.6 (1.9)	0.3300	67.3 (1.9)	56.7 (2.2)	60.3 (2.2)	0.0299
≥ 1	73.7 (2.0)	68.1 (1.7)	71.3 (1.8)	0.1272	88.7 (2.2)	85.1 (2.5)	86.3 (1.7)	0.2741
Individual components								
WC	21.0 (1.1)	22.4 (1.1)	21.6 (1.3)	0.6187	38.2 (1.7)	32.3 (1.9)	34.3 (2.2)	0.2717
High BP	29.4 (1.2)	34.4 (1.2)	31.5 (1.6)	0.0766	65.8 (2.0)	63.0 (2.1)	63.9 (2.2)	0.5665
IFG	7.2 (0.6)	8.0 (0.5)	7.5 (0.8)	0.6224	27.4 (1.4)	22.8 (1.4)	24.3 (1.9)	0.2551
Low HDL	48.3 (1.7)	40.8 (1.5)	45.1 (1.9)	0.0465	51.0 (1.9)	45.0 (2.2)	47.0 (2.3)	0.2167
High TG	35.8 (1.5)	38.2 (1.4)	36.8 (1.9)	0.4830	43.7 (1.7)	32.1 (1.9)	36.0 (2.1)	0.0317

[Sample number/Total estimated Korean workers]. All values were estimated percentage and standard error. *Occurrence of the metabolic syndrome and combinations of its components. WC: waist circumference; BP: blood pressure; IFG: impaired fasting glucose; HDL: high-density lipoprotein; TG: triglyceride.

Table 3. Estimated prevalence of metabolic syndrome and components in the Korean female adult working population by type of work and age

	< 50				≥ 50			
	Nonmanual [732/4,679,107]	Manual [268/1,471,041]	Total [1,000/6,150,148]	*p*-value	Nonmanual [157/792,559]	Manual [324/1,329,205]	Total [481/2,121,764]	*p*-value
Metabolic syndrome components*								
≥ 3	4.6 (0.6)	13.7 (0.7)	6.8 (0.9)	< 0.0001	44.7 (2.4)	29.4 (2.1)	35.1 (2.7)	0.0069
≥ 2	17.8 (1.2)	34.9 (1.1)	21.9 (1.5)	< 0.0001	70.1 (2.8)	58.7 (2.8)	62.9 (2.6)	0.0315
≥ 1	63.1 (2.1)	74.0 (1.5)	65.7 (1.8)	0.0205	89.2 (3.0)	83.1 (2.8)	85.4 (2.0)	0.1462
Individual components								
WC	12.5 (1.2)	23.3 (0.9)	15.1 (1.5)	0.0015	43.6 (2.1)	33.5 (2.0)	37.3 (2.3)	0.0465
High BP	7.7 (0.8)	16.8 (0.8)	9.9 (1.1)	0.0004	54.4 (2.8)	52.5 (2.6)	53.2 (3.0)	0.7277
IFG	2.6 (0.5)	7.5 (0.6)	3.8 (0.7)	0.0048	14.7 (1.1)	12.5 (1.4)	13.3 (1.9)	0.5218
Low HDL	56.8 (2.1)	65.4 (1.5)	58.9 (1.8)	0.0651	73.6 (2.6)	66.3 (2.7)	69.0 (2.3)	0.1464
High TG	8.8 (0.9)	14.7 (0.6)	10.2 (1.1)	0.0186	42.6 (2.3)	24.7 (2.1)	31.4 (2.8)	0.0016

[Sample number/Total estimated Korean workers]. All values were estimated percentage and standard error. *Occurrence of the metabolic syndrome and combinations of its components, WC: waist circumference; BP: blood pressure; IFG: impaired fasting glucose; HDL: high-density lipoprotein; TG: triglyceride.

(manual workers had higher risk for metabolic syndrome in younger workers, while nonmanual workers had higher risk for metabolic syndrome in older workers). However, unlike women workers' pattern, these associations by age and occupation were not as distinctive in men workers. Korean men of higher socioeconomic status have a more sedentary lifestyle and many opportunities to consume richer foods and alcohol beverages but less opportunity to engage in physical labor[8]. This trend doesn't seem to be overcome enough until now in nonmanual workers. Considering the fact that male workers' metabolic syndrome by age and occupation showed the similar direction with female workers in this study, it is possible that, even in men workers, disparities between manual and nonmaual will be widened in the future.

A transition in CVD risk factors is likely to exist in countries such as Korea where the socio-cultural changes have occurred rapidly over decades of great socioeconomic upheaval. Nonmanual workers (specialists, office workers and self-employed workers) in Korea have been categorized into upper class for several decades. Nonmanual workers considered to be similar to those with a

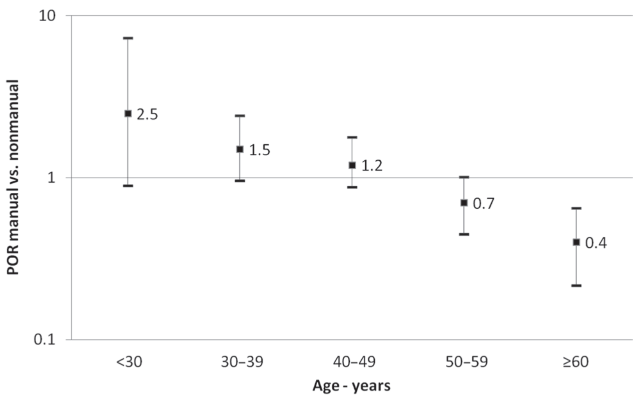

Fig. 1. The POR for metabolic syndrome according to their occupation (nonmanual workers = reference) by age.

high level of education and income for several decades. According to a study of the trends over the last decade in the relationship between SEP and obesity among Koreans, a significant decline in the prevalence of obesity was shown among those with a high level of education and income[16]. This reflected the stereotype that upper class individuals would have appeared overweight because they were well nourished. Furthermore, smoking and drinking were acceptable culturally among Koreans up to the last two decades. However, this pattern has recently undergone rapid change[16, 17]. Recently, manual workers are regarded as stereotype of overweight and consuming more tobacco and alcohol than nonmanual workers. From a cross sectional view, both the aged, who have experienced these transitions in lifestyle, and the young, who have not, coexist in the same period. This suggests that the distribution of health outcomes by classes can appear differently depending on age. Women of high socioeconomic position tend to be more concerned about their fitness, consume healthy food, and practice regular exercise[8, 10]. This kind of pattern might explain the stronger association between occupation and metabolic syndrome in women. Especially, the younger generation can easily adapt to this tendency.

Our study has some limitations. First, the study design was cross-sectional and so we could not evaluate the causal relationship between metabolic syndrome and occupation over time. Additionally, in order to elucidate the role of physical activity in the relationship between occupation and metabolic syndrome, we analyzed the prevalence of optimal physical activity according to occupation and age in women workers. In young women workers (less than 50 yr old), manual workers who do optimal physical activity are 25.3%. On the other hand, 16.3% of nonmanual workers do optimal physical activity. In old women workers (50 and more than 50 yr old), workers who do optimal physical activity are 24.0% and 28.5% in manual workers and nonmanual workers, respectively. This result shows that physical activity is not the only reason for the prevalence difference in metabolic syndrome according to age and occupation. In addition, unfortunately, we could not explain the temporal relationship between physical activity and metabolic syndrome in cross sectional study. Further research is necessary to evaluate the mechanism of the association between occupation and metabolic syndrome. Quality of food intake, job stress, and occupational activities might be other explanatory factors for this association. Second, we did not consider other occupational factors such as job stress and long working hours. There are many studies dealing with the association between psychosocial work environments and cardiovascular disease risk factors[18–20]. Especially, long working hours is still prevalent in Korea, so, we should notice this issue. Through the further study, we are planning to find out the relationship

Table 4. Prevalence odds ratios (95% confidence intervals) of metabolic syndrome by age and occupational group

Age	Group	Model I*		Model II†	
		Male	Female	Male	Female
Total	Nonmanual	Reference	Reference	Reference	Reference
	Manual	0.90 (0.69–1.18)	0.85 (0.55–1.30)	0.95 (0.73–1.24)	0.85 (0.55–1.30)
< 50	Nonmanual	Reference	Reference	Reference	Reference
	Manual	1.09 (0.79–1.51)	1.96 (1.12–3.45)	1.10 (0.79–1.53)	1.95 (1.12–3.40)
≥ 50	Nonmanual	Reference	Reference	Reference	Reference
	Manual	0.71 (0.46–1.10)	0.37 (0.23–0.60)	0.74 (0.48–1.15)	0.36 (0.22–0.59)

*Model I: PORs of manual vs. nonmanual workers by logistic regression, adjusted for age. †Model II: PORs of manual vs. nonmanual workers by multivariate survey logistic regression, adjusted for age, smoking, alcohol consumption, physical activity.

between various work characteristics and CVD risk factors in Korea. Third, there is a possibility that manual workers are more likely to leave labor force earlier than nonmanual workers. Thus older maunal workers who still work may be relatively healthier than older non-manual workers. This healthy worker effect might influence our study's findings. However, such effect, if ever, seems to be minor because, in Korea, due to a weak social safety net, there is little chance for manual workers to leave labor force earlier unless they experience severe injuries to be disabled. So, a healthy worker "survivor" effect cannot completely explain the pattern of association between metabolic syndrome and occupation by age. Lastly, we could not definitely determine what might affect the incidence of metabolic syndrome at a specific age. Nevertheless, the stratified multistage clustered probability design of KNHANES III was considered and a survey analysis was conducted to estimate the prevalence of metabolic syndrome in workers in Korea. We found that the estimated number of workers was similar to that identified in the national labor statistics in 2005 (22.0 million vs. 22.5 million)[21]. With this method, we can estimate the prevalence of metabolic syndrome more precisely with survey procedures. In addition, because the analysis was stratified into age and gender subgroups to evaluate effect modification; the analysis also reduced the possibility of confounding by age and gender.

The results of the study may serve as a basis for establishing age and gender specific prevention approach of cardiovascular disease in Korean workers. This result also has implications for future studies on metabolic syndrome of workers in other countries which are experiencing rapid increase of cardiovascular disease during abrupt socioeconomic changes.

Conclusions

The results of this study provide evidence that there are different associations between metabolic syndrome and occupational class depending on age and gender with adjustment for health behavior factors. Further studies, especially a longitudinal analysis, will be required to confirm how the occupation can affect the prevalence of metabolic syndrome and its trends in Korea.

Acknowledgements

We thank the Korea Centers for Disease Control and Prevention for providing the data.

References

1) Nestel P, Lyu R, Low LP, Sheu WH, Nitiyanant W, Saito I, Tan CE (2007) Metabolic syndrome: recent prevalence in East and Southeast Asian populations. Asia Pac J Clin Nutr **16**, 362–7.
2) Rakugi H, Ogihara T (2005) The metabolic syndrome in the asian population. Curr Hypertens Rep **7**, 103–9.
3) Statistics Korea. Statistics of the cause of death in Korea, 2005–2007. http://kosis.kr/nsportal/abroad/aboard_01List.jsp. Accessed May 30, 2011 (in Korean).
4) Johnson LW, Weinstock RS (2006) The metabolic syndrome: concepts and controversy. Mayo Clin Proc **81**, 1615–20.
5) Alegría E, Cordero A, Laclaustra M, Grima A, León M, Casasnovas JA, Luengo E, del Rio A, Ferreira I, Investigadores del registro MESYAS (2005) Prevalence of metabolic syndrome in the Spanish working population: MESYAS Registry. Rev Esp Cardiol **58**, 797–806.
6) Dallongeville J, Cottel D, Ferrieres J, Arveiler D, Bingham A, Ruidavets JB, Hass B, Ducimetiere P, Amouyel P (2005) Household income is associated with the risk of metabolic syndrome in a sex-specific manner. Diabetes Care **28**, 409–15.
7) Salsberry PJ, Corwin E, Reagan PB (2007) A complex web of risks for metabolic syndrome: race/ethnicity, economics, and gender. Am J Prev Med **33**, 114–20.
8) Park MJ, Yun KE, Lee GE, Cho HJ, Park HS (2007) A cross-sectional study of socioeconomic status and the metabolic syndrome in Korean adults. Ann Epidemiol **17**, 320–6.
9) Ford ES, Giles WH, Dietz WH (2002) Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. JAMA **287**, 356–9.
10) Sanchez-Chaparro MA, Calvo-Bonacho E, Gonzalez-Quintela A, Fernandez-Labandera C, Cabrera M, Sainz JC, Fernandez-Meseguer A, Banegas JR, Ruilope LM, Valdivielso P, Román-García J (2008) Occupation-related differences in the prevalence of metabolic syndrome. Diabetes Care **31**, 1884–5.
11) Grundy SM, Cleeman JI, Merz CN, Brewer HB, Jr., Clark LT, Hunninghake DB, Pasternak RC, Smith SC, Jr., Stone NJ (2004) Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III Guidelines. J Am Coll Cardiol **44**, 720–32.
12) WHO Expert Consultation (2004) Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet **363**, 157–63.
13) Alberti KG, Zimmet P, Shaw J, IDF Epidemiology Task Force Consensus Group (2005) The metabolic syndrome—a new worldwide definition. Lancet **336**, 1059–62.
14) Korea Center for Disease Control and Prevention (2006) Korean National Health and Nutrition Examination Survey Report 2005. http://knhanes.cdc.go.kr/. Accessed March 15,

2011.
15) Davila EP, Florez H, Fleming LE, Lee DJ, Goodman E, LeBlanc WG, Caban-Martinez AJ, Arheart KL, McCollister KE, Christ SL, Clark JC 3rd, Clarke T (2010) Prevalence of the metabolic syndrome among U.S. workers. Diabetes Care **33**, 2390–5.
16) Yoo S, Cho HJ, Khang YH, General and abdominal obesity in South Korea, 1998–2007 (2010) Gender and socioeconomic differences. Prev Med **51**, 460–5.
17) Khang YH, Yun SC, Lynch JW (2008) Monitoring trends in socioeconomic health inequalities: it matters how you measure. BMC Public Health **8**, 66.
18) Chandola T, Britton A, Brunner E, Hemingway H, Malik M, Kumari M, Badrick E, Kivimaki M, Marmot M (2008) Work stress and coronary heart disease: what are the mechanisms? Eur Heart J **29**, 640–8.
19) Choi B, Schnall PL, Yang H, Dobson M, Landsbergis P, Israel L, Karasek R, Baker D (2010) Psychosocial working conditions and active leisure-time physical activity in middle-aged us workers. Int J Occup Med Environ Health **23**, 239–53.
20) Yoo H, Franke WD (2011) Stress and cardiovascular disease risk in female law enforcement officers. Int Arch Occup Environ Health **84**, 279–86.
21) Statistics Korea. Summary of economically active population. http://kosis.kr/nsportal/eng/database/database_001000.jsp?listid=E&subtitle=Employment, Labor, Wages. Accessed March 15, 2011.