Prevalence of Metabolic Syndrome and Lifestyle Characteristics by Business Type among Japanese Workers in Small- and Medium-sized Enterprises

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(Received for publication on June 19, 2018)

(Revised for publication on October 30, 2018)

(Accepted for publication on November 8, 2018)

(Published online in advance on December 14, 2018)

This cross-sectional study investigated the associations of business type with the prevalence of metabolic syndrome (MetS) and lifestyle characteristics among workers in small- and medium-sized enterprises. In total, data from 167,736 workers (114,746 men and 52,990 women) who participated in health checkups in 2013 were analyzed using multilevel logistic regression models. The odds ratios (ORs) of having MetS, defined based on the criteria of the joint interim statement, were significantly higher in employees of transportation businesses (reference OR =1) than in other business types among men (OR: 0.67–0.85) and similar result was observed among women (OR: 0.70–0.88). The prevalence of a smoking habit was significantly higher in transportation workers than in employees of other businesses for both men and women. Furthermore, male transportation workers were more likely to skip breakfast, engage in <1 h/day of walking, walk at a slower speed, and eat dinner just before going to bed. Female transportation workers were more likely to have gained 10 kg since the age of 20 years. In conclusion, the prevalence of MetS was higher in transportation workers than in workers from other businesses; the associated risk factors may also vary by sex. To effectively promote public health, the labor environment, such as the business type, should be considered. (DOI: 10.2302/kjm.2018-0007-OA; Keio J Med 68 (3) : 54–67, September 2019)

Keywords: occupational health, health risk behaviors, metabolic syndrome, small business, SME

Introduction

To reduce cardiovascular disease, healthcare professionals have focused on control of low-density lipoprotein cholesterol (LDL-C). However, because cardiovascular disease can still develop even with control of LDL-C, and because it was revealed that multiple risk factors are involved (mainly insulin resistance and abdominal obesity),¹ metabolic syndrome (MetS) has been identified as a residual risk factor for cardiovascular disease,² which is a major public health issue worldwide.^{3–5}

Risk factors for MetS include lifestyle habits, such as alcohol intake, dietary intake, and a lack of regular exercise.^{6–8} Regarding physical activity in Japan, only a minority of men (20.3%) and women (13.4%) in their 40s exercise regularly.⁹ In Japan, 25.6% of men and 14.9% of women in their 40s skip breakfast.⁹ Therefore, middle-aged workers, in particular, need support to improve their lifestyle habits to prevent MetS and other lifestyle-related diseases.

It is especially difficult to reach workers in small- and medium-sized enterprises (SMEs). This is important,

because health risks are reportedly significantly more prevalent in employees of SMEs (<300 employees) than in those employed by large-scale enterprises ($\geq 1,000$ employees).^{10,11} Furthermore, because of the diversity in working hours, type of employment, and workplaces, addressing health education and habits in the labor environment of these workers is warranted to improve health behavior. Such ecological models are an effective way to promote health behavior.¹²

To approach workers in the SME environment, business type is one factor to be considered. However, considering the labor environment, only a few studies have reported the association between health outcome and business type,^{10,13,14} albeit with inconsistent results. Of these, one study showed that the prevalence of MetS was significantly higher in men employed in construction;¹⁴ however the company size in that study was not clear.

Therefore, to better understand the relationship between the business type and MetS risk factors in SMEs, this study aimed to analyze the prevalence of MetS and related lifestyle characteristics among workers in SMEs (<300 workers) according to the business type.

Materials and Methods

Study participants

According to the Statistics Bureau, Ministry of Internal Affairs and Communications, 99.4% of all enterprises in Japan are small or medium in size.¹⁵ In 2013, health checkups for 240,022 workers aged 35–74 years were conducted in a prefecture in Japan by a health insurance association that provides insurance for laborers and SMEs (<10 employees, 39,586 [16.5%]; 10–29 employees, 48,653 [20.3%]; 30–49 employees, 23,617 [9.8%]; 50–99 employees, 35,391 [14.7%]; 100–299 employees, 37,447 [15.6%]; 300–999 employees, 25,286 [10.5%]; $\geq 1,000$ employees, 19,767 [8.2%]; whose company size is unclear, 10,275 [4.4%]). In the current study, we defined SMEs as companies with <300 employees, in accordance with previous studies.^{10,11} We determined the number of workers in each enterprise by using the number of workers insured for each company, which was calculated in March 2013.

Workers who participated in health checkups and who worked at companies with 300 employees ($n = 45,053$) or more or whose company size was unclear ($n = 10,275$) were excluded. Workers who participated in health checkups and whose age and sex were unclear ($n = 144$), whose data regarding MetS diagnostic criteria were unavailable ($n = 16,356$), or who did not have company data ($n = 458$) were also excluded. Thus, the final analytic sample consisted of 167,736 workers (**Fig. 1**). The participation rate in checkups in 2013 was 43.1%. Dependents of workers were not included in the current study.

During their checkups, the participants answered a

self-administered questionnaire that covered their smoking, alcohol consumption, physical activity, dietary, and sleep habits. Trained staff then measured the height, weight, waist circumference, and blood pressure of each participant and collected blood samples.

Measurements

Body weight (kg) and height (cm) were measured using a digital scale and stadiometer, respectively, with the participant barefoot. The body mass index (BMI) was calculated as body weight (kg) divided by the square of body height (m). The waist circumference was measured at the level of the navel and during the late expiratory phase with the participant in the standing position. Blood pressure was measured twice using an automated sphygmomanometer with the participant in the seated position, and the mean value for each participant was recorded. Triglycerides, high-density lipoprotein cholesterol (HDL-C), and fasting glucose levels were measured using the blood samples. The fasting condition was confirmed by inquiry (>10 h without a meal). If the participant could not confirm fasting, the HbA1c level was also measured. MetS was diagnosed based on the presence of three of the following five risk criteria from the joint statement by the International Diabetes Federation; the American Heart Association; National Heart, Lung, and Blood Institute; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity¹⁶: (1) waist circumference ≥ 90 cm in men and ≥ 80 cm in women (based on Asian populations); (2) hypertension: systolic blood pressure ≥ 130 mmHg, diastolic blood pressure ≥ 85 mmHg, or treatment with antihypertensive drugs; (3) high fasting glucose ≥ 100 mg/dL or treatment with antihyperglycemic drugs (if the participant was not fasting, HbA1c (NGSP) $> 5.6\%$ was used instead¹⁷); (4) hypertriglyceridemia ≥ 150 mg/dL or treatment with antihypertriglyceridemic drugs; and (5) low HDL-C < 40 mg/dL in men and < 50 mg/dL in women or treatment with drugs to raise HDL-C level.

Appendix 1 displays the self-administered questionnaire. We included 12 questions related to lifestyle habits in this study. The following responses were classified as high risk: weight gain, “yes” to “Have you gained ≥ 10 kg since you were 20 years old?”; dietary habits, “yes” to “Do you have an evening meal within 2 h before bedtime 3 days or more per week?” “Do you eat after the evening meal (have a fourth meal) 3 days or more per week?” and “Do you skip breakfast 3 days or more per week?”; speed of eating, “faster” to “How fast do you eat compared to others?”; and physical activity and sleeping habits, “no” to “Have you been exercising at least 2 days per week, at least 30 minutes each at an intensity that causes a slight sweat, for at least 1 year?” (no to low-intensity exercise), “Do you walk for at least 1 h every day or have equivalent

Fig. 1 Flowchart of enrollment.

physical activities in your daily life?” (engage in <1 h/day of walking), “Do you walk faster than people of your age and sex?” (walk at a slower speed), and “Do you feel refreshed after a night’s sleep?” (not feel refreshed after a night’s sleep). For the questions regarding drinking habits, drinking “every day” or “sometimes” and ≥ 1 serving were classified as high risk (there is a possibility of consuming >40 g/day of pure alcohol in men and >20 g/day in women).^{10,18}

Statistical analysis

For the analysis, the participants were classified by age group (35–40, 41–50, 51–60, 61–70, and 71–74 years) and by business type. According to the Economic Census for Business Frame,¹⁹ there are 42 industrial classifications in 18 categories, which are further classified into eight similar business types: (1) transportation, (2) construction, (3) manufacturing, (4) information and communication, (5) wholesale trade, (6) services, (7) healthcare, and (8) others. Company size was classified into five groups (<10, 10–29, 30–49, 50–99, and 100–299 employees) by referring to the Economic Census for Business Frame.¹⁹

The proportion of participants with health risks and differences in company size by business type were assessed using chi-squared tests. Multilevel mixed-effects logistic regression (the GENLINMIXED module: GLMM),

which accounts for multilevel measurements per participant and the nesting of participants within companies, was used to examine associations of MetS (0=no MetS, 1=presence of MetS) and other participant characteristics (current smoking: 0=current non-smoker, 1=smoker; other lifestyle characteristics: 0=no, 1=yes) with business type (with transportation as the reference). The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for each factor. The models were adjusted for age and company size. In addition, we confirmed each variable with a 95% CI by inverting the reference of raw data. To confirm the association between MetS and lifestyle habits, we conducted multilevel logistic regression by adding each lifestyle habit that was significantly related to business type. All analyses were conducted using the Statistical Package for Social Sciences (SPSS) Statistics, version 23 (IBM Japan).

Ethical Issues

Comprehensive agreement to participate in the study was included in the Medical Consultation Form, in which participants were informed that the data from the health checkups might be used for anonymous statistical analysis. This study was approved by the Ethics Committee of the Graduate School of Health Management, Keio University, Kanagawa, Japan (No. 2015–06).

Results

Tables 1 and 2 display the participant characteristics and lifestyle habits, respectively. The mean $\pm$ standard deviation (SD) age of the participants was 49.5 ± 9.9 years in men and 49.7 ± 9.1 years in women; 16.6% of men and 14.9% of women had MetS, and 44.9% of men and 20.3% of women had a smoking habit. **Table 3** displays the company characteristics. Construction made up the largest number of companies (16.2%), whereas information and communication made up the smallest (3.3%). The most common company size was 1–9 employees (62.2%), whereas the least common company size was 100–299 employees (2.6%). Of the different business types, transportation employees showed the highest prevalence of MetS (men, 21.8%; women, 18.2%), smoking habit (men, 55.3%; women, 29.4%). Transportation also had the highest, or high, values for many other high-risk factors (**Table 4**).

Because the percentages of participants with MetS were the highest for the transportation business type for both men and women, we conducted multilevel mixed-effects logistic regression using transportation as the reference business type; the results are shown in **Fig. 2**. The odds ratios (ORs) for having MetS, defined based on criteria of the joint interim statement, were significantly higher in workers of the transportation business (reference OR = 1) than in other business types among men (OR: 0.67–0.85) and similar result was observed among women (OR: 0.70–0.88). For both men and women, the prevalence of a smoking habit was significantly higher in transportation workers than in employees of other businesses. **Table 5** outlines the lifestyle habits among the different groups of workers. For both men and women, a smoking habit was significantly more prevalent in transportation employees than in employees of other businesses. Furthermore, among men, the ORs for “engage in <1 h/day of walking,” “walk at a slower speed,” “meal before bedtime,” and “skipping breakfast” were significantly higher among transportation workers than among employees of other business types. Among women, the OR for “weight gained since age 20 years” was significantly higher in transportation than in other business types. **Table 6** shows the results of GLMM by adding each lifestyle habit that was significantly related to business type. All lifestyle habits, except smoking in men and skipping breakfast in women, were significantly related to MetS.

Because participants aged 70–74 years accounted for a very small proportion of the workers, an additional analysis was carried out excluding this group (data not shown). The results were the same except for “meal before bedtime”: one business type was not significant for this factor, but similar relations were observed overall.

Discussion

This cross-sectional study analyzed the associations between business type, the prevalence of MetS, and related lifestyle factors among employees of SMEs. We found that, for both men and women, MetS and related health risk behaviors were significantly more common in transportation workers. This result is consistent with a previous study that found that the prevalences of MetS and hypertension in bus drivers was 49.9% and 53.3% which was higher than 23.8% and 19.7% in the crafts and machine operators’ group, respectively.²⁰

The prevalence of MetS in the current study was similar to that in the 2014 Japan Epidemiology Collaboration on Occupational Health (J-ECOH) Study (23.3% for men and 12.7% for women). The J-ECOH Study is a large enterprise-based study that included participants aged 20–69 years and which used the same criteria for MetS as our study did.²¹

Furthermore, the current study revealed that male transportation workers were significantly more likely to skip breakfast, engage in <1 h/day of walking, walk at a slower speed, and have dinner just before going to bed than those in other business categories. Female transportation workers were significantly more likely to have gained 10 kg since the age of 20 years. Japanese guidelines recommend 1 h per day of physical activity at an intensity level of at least 3 metabolic equivalents for 18–64 years,²² and gait speed is known to be associated with survival in older adults.²³ Considering dietary habits and weight gain, both skipping breakfast^{24,25} and weight gain from age 20 years^{26,27} are associated with the development of MetS. Moreover, according to the Survey on Industrial Accidents, transportation workers have the highest number of insurance claims for cerebral and cardiac diseases (26%).²⁸ Consequently, it might be effective to promote improvement in these unhealthy lifestyle habits among transportation workers to prevent MetS; such measures could also help prevent cardiovascular disease.

The prevalence of a smoking habit in the J-ECOH Study was 18% overall, 30.1% in men, and 8.0% in women²¹; the rates in men and women were both higher than national results obtained from people aged more than 30 years.⁹ Moreover, the prevalence of smoking in the current study was higher than that in the J-ECOH Study, especially among transportation workers. Because smoking coupled with obesity contributes substantially to all-cause mortality,²⁹ smoking cessation programs targeted toward the transportation industry could be an important population-based approach for the prevention of cardiovascular diseases. The Monthly Labor Survey reported that the average working hours were 149.0 h/month across all business types, whereas transportation workers worked 170.9 h/month. This is the second longest working hour duration among the different business types after those of construction workers, who work 174.5 h/month.³⁰ Previ-

Table 1. Participant characteristics

Variable	Men (n =114,746)	Women (n =52,990)
Individual level		
Age (years) ^{*1}	49.5 ± 9.9	49.7 ± 9.1
Age group (years) ^{*2}		
35–39	19,150 (17.7)	7,487 (14.9)
40–49	41,207 (38.2)	18,942 (37.6)
50–59	25,676 (23.8)	15,551 (30.9)
60–69	19,520 (18.1)	7,597 (15.1)
70–74	2,387 (2.2)	795 (1.6)
Body height (cm) ^{*1}	170.1 ± 0.1	157.5 ± 0.1
Body weight (kg) ^{*1}	69.5 ± 11.6	54.9 ± 9.8
BMI (kg/m ²) ^{*1}	24.0 ± 3.6	22.1 ± 3.8
Waist circumference (cm) ^{*1}	84.6 ± 9.6	78.4 ± 10.4
High level of low-density lipoprotein cholesterol ^{a *2}	17,830 (15.5)	6,550 (12.4)
Large waist circumference	29,941 (26.1)	20,848 (39.3)
Hypertension	53,489 (46.6)	14,516 (27.4)
Hyperglycemia	47,284 (41.2)	13,213 (24.9)
Hypertriglyceridemia	38,035 (33.1)	7,364 (13.9)
Low high-density lipoprotein cholesterol	14,709 (12.8)	7,469 (14.1)
Metabolic syndrome ^{b *2}	18,993 (16.6)	7,917 (14.9)
Large waist circumference	12,098 (63.7)	6,982 (88.2)
Hypertension	15,726 (82.8)	6,000 (75.8)
Hyperglycemia	15,613 (82.2)	6,514 (82.3)
Hypertriglyceridemia	15,227 (80.2)	5,330 (67.3)
Low high-density lipoprotein cholesterol	11,129 (58.6)	5,069 (64.0)
Company level		
Business type ^{*2}		
Construction	15,266 (13.3)	3,247 (6.1)
Manufacturing	26,201 (22.8)	8,170 (15.4)
Information and communication	2,343 (2.0)	616 (1.2)
Transportation	13,631 (11.9)	1,752 (3.3)
Wholesale trade	16,157 (14.1)	7,371 (13.9)
Services	19,462 (17.0)	8,822 (16.6)
Healthcare	6,354 (5.5)	14,726 (27.8)
Others	15,332 (13.8)	8,286 (15.6)
Company size (number of employees) ^{*2}		
1–9	24,218 (21.1)	11,360 (21.4)
10–29	30,711 (26.8)	13,741 (25.9)
30–49	14,987 (13.1)	6,610 (12.5)
50–99	21,592 (18.8)	10,525 (19.9)
100–299	23,238 (20.3)	10,754 (20.3)

^{*1} Mean±SD, ^{*2} number (%).

^a High low-density lipoprotein cholesterol ≥ 160 mg/dL.

^b Metabolic syndrome was diagnosed based on the presence of three of the five risk criteria from the joint statement by the International Diabetes Federation; American Heart Association; National Heart, Lung, and Blood Institute; World Heart Federation, International Atherosclerosis Society; and International Association for the Study of Obesity.¹⁰

Table 2. Participant lifestyle habits

Variable	Men		Women	
	n	%	n	%
Current smoker	51,490	44.9	10,760	20.3
Gained ≥ 10 kg since age 20 years	34,436	45.2	9,027	24.5
Change weight (± 3 kg in a year)	23,065	20.1	9,694	26.4
No exercise habit ^a	58,046	76.3	30,427	82.7
Engage in < 1 h/day of walking	46,339	60.8	22,649	61.6
Walk at a slower speed	38,927	51.2	19,818	54.0
Eat faster compared to others ^b	28,353	37.4	11,265	30.9
Eat dinner before going to bed	34,052	44.7	10,651	29.0
Eat after the evening meal	11,559	15.2	7,084	19.3
Skip breakfast	22,331	29.8	7,122	19.8
Alcohol risk ^c	16,033	24.2	6,105	21.4
Not feel refreshed after a night's sleep	30,019	39.5	16,576	45.2

^a "Have you been exercising at least 2 days per week, at least 30 min each at an intensity that causes a slight sweat, for at least 1 year?"

^b The answer "faster" was classified as being associated with higher risk.

^c Consumption of > 20 g of alcohol per serving for men (≥ 2 to < 3 servings) and > 10 g for women (≥ 1 to < 2 servings) was classified as high risk.¹¹

Table 3. Company characteristics

Variable	(n = 22,567)	
Business type	Number of companies	%
Construction	3,650	16.2
Manufacturing	3,367	14.9
Information and communication	755	3.3
Transportation	956	4.2
Wholesale trade	3,553	15.7
Services	3,250	14.4
Healthcare	2,290	10.1
Others	4,746	21.0
Company size (number of employees)		
1–9	14,045	62.2
10–29	5,557	24.6
30–49	1,320	5.8
50–99	1,066	4.7
100–299	579	2.6

ous studies have shown that long working hours are associated with poor diet quality,³¹ smoking,³² and physical inactivity.³³ Because transportation workers likely work prolonged hours, it may be difficult for them to maintain healthy lifestyle habits. Among transportation workers, irregular lifestyles can also sometimes cause sleep disorders.^{34,35} Previous studies have shown relationships between sleep apnea syndrome and BMI,³⁶ and between sleepiness (Epworth Sleepiness Scale) and BMI and the major components of MetS (waist circumference, hypertension, and hypertriglyceridemia).³⁷

Associations of various health-related factors with the business type of transportation have also been reported.^{38,39} One study showed that transportation workers had significantly higher rates of obesity and more frequent smoking habits than the average U.S. worker.³⁹

As shown in **Table 6**, all lifestyle habits except smoking in men and skipping breakfast in women were significantly related to MetS, and a similar association was observed among business types. These findings show that, while lifestyle habits mediate some part of the relationships between business type and MetS, business type

Table 4. Health risk factors and lifestyle habits by business type (n [%])

Men	Information and communication							p value ^a
	Transportation	Construction	Manufacturing	Wholesale Trade	Services	Healthcare	Others	
Age, mean $\pm$ SD	52.0 $\pm$ 9.7	49.3 $\pm$ 9.9	49.0 $\pm$ 9.6	45.9 $\pm$ 8.5	48.7 $\pm$ 9.6	50.0 $\pm$ 10.1	47.9 $\pm$ 10.0	<0.001
BMI, mean $\pm$ SD	24.4 $\pm$ 3.9	24.4 $\pm$ 3.5	23.6 $\pm$ 3.5	24.2 $\pm$ 3.7	24.0 $\pm$ 3.6	23.9 $\pm$ 3.6	23.8 $\pm$ 3.7	<0.001
High level of low-density lipoprotein cholesterol	2,214 (22.2)	2,002 (17.9)	2,933 (14.5)	318 (19.4)	2,003 (16.5)	2,416 (16.4)	772 (15.7)	<0.001
Metabolic syndrome	2,970 (21.8)	2,700 (17.7)	3,682 (14.1)	361 (15.4)	2,585 (16.0)	3,140 (16.0)	998 (15.7)	<0.001
Large waist circumference	1,993 (67.1)	1,769 (65.5)	2,217 (60.2)	235 (65.1)	1,686 (65.2)	2,013 (64.1)	640 (64.1)	<0.001
Hypertension	2,577 (86.8)	2,210 (84.5)	3,110 (84.5)	258 (71.5)	2,069 (80.0)	2,585 (82.3)	838 (84.0)	<0.001
Hyperglycemia	2,351 (79.2)	2,202 (81.6)	3,015 (81.9)	289 (80.1)	2,159 (83.5)	2,610 (83.5)	828 (83.0)	<0.001
Hypertriglyceridemia	2,428 (81.8)	2,166 (80.2)	2,967 (80.6)	302 (83.7)	2,026 (78.4)	2,491 (79.3)	779 (78.1)	0.012
Low high-density lipoprotein cholesterol	1,808 (60.9)	1,526 (56.5)	2,156 (58.6)	229 (63.4)	1,496 (57.9)	1,810 (57.6)	567 (56.9)	0.005
Current smoker	7,534 (55.3)	7,806 (51.2)	11,361 (43.4)	877 (37.4)	7,224 (44.7)	8,753 (45.0)	2,259 (35.6)	<0.001
Gained $\geq$ 10 kg since age 20 years	4,426 (48.6)	4,669 (50.5)	6,855 (40.8)	878 (50.8)	5,097 (45.6)	5,836 (43.0)	1,679 (40.7)	<0.001
Change weight ($\pm$ 3 kg in a year)	2,794 (30.7)	3,141 (34.0)	4,603 (27.4)	569 (33.0)	3,489 (31.3)	4,025 (29.7)	1,290 (31.2)	<0.001
No exercise habit	7,146 (78.9)	6,986 (75.6)	13,121 (78.3)	1,414 (81.6)	8,442 (75.7)	10,084 (74.7)	3,080 (74.6)	<0.001
Engage in <1 h/day of walking	6,514 (71.5)	5,269 (57.0)	10,665 (63.6)	1,117 (64.7)	6,573 (58.9)	7,522 (55.5)	2,243 (54.3)	<0.001
Walk at a slower speed	5,270 (58.0)	4,852 (52.5)	9,013 (53.8)	810 (46.9)	5,360 (48.0)	6,533 (48.3)	2,034 (49.4)	<0.001
Eat faster compared to others	2,927 (32.2)	3,512 (38.3)	5,792 (34.7)	627 (36.7)	4,340 (39.1)	5,310 (39.5)	1,761 (43.0)	<0.001
Eat dinner before going to bed	4,556 (50.0)	4,604 (49.8)	6,712 (40.0)	793 (46.0)	5,407 (48.4)	5,883 (43.4)	1,578 (38.2)	<0.001
Eat after the evening meal	1,428 (15.7)	1,395 (15.1)	2,532 (15.1)	255 (14.8)	1,636 (14.6)	2,088 (15.4)	754 (18.3)	<0.001
Skip breakfast	3,412 (37.6)	2,731 (30.4)	4,194 (25.3)	529 (31.7)	3,575 (32.4)	4,263 (31.9)	985 (24.3)	<0.001
Alcohol risk	1,862 (23.2)	1,828 (22.3)	3,281 (22.9)	525 (34.4)	2,358 (24.0)	2,777 (24.2)	921 (26.4)	<0.001
Not feel refreshed after a night's sleep	3,642 (40.0)	3,522 (38.2)	6,605 (39.4)	741 (43.1)	4,535 (40.7)	5,466 (40.4)	1,633 (39.7)	<0.001

Table 4. Health risk factors and lifestyle habits by business type (n [%]) (continued)

Women	Transportation	Construction	Manufacturing and communi- cation	Wholesale Trade	Services	Healthcare	Others	<i>p</i> value ^a
Age mean $\pm$ SD	50.0 $\pm$ 9.2	50.4 $\pm$ 9.5	50.1 $\pm$ 9.3	48.9 $\pm$ 9.1	50.5 $\pm$ 9.3	49.7 $\pm$ 8.7	49.0 $\pm$ 8.8	<0.001
BMI mean $\pm$ SD	22.6 $\pm$ 4.3	22.0 $\pm$ 3.7	22.4 $\pm$ 3.9	21.9 $\pm$ 3.7	21.9 $\pm$ 3.6	22.4 $\pm$ 3.9	21.8 $\pm$ 3.5	<0.001
High level of low-density lipoprotein cholesterol	289 (16.5)	489 (15.1)	1,289 (15.8)	982 (13.3)	1,194 (13.5)	2,055 (14.0)	1,101 (13.3)	<0.001
Metabolic syndrome	318 (18.2)	518 (16.0)	1,359 (16.6)	1,026 (13.9)	1,333 (15.1)	2,251 (15.3)	1,046 (12.6)	<0.001
Large waist circumference	286 (89.9)	451 (87.1)	1,190 (87.6)	920 (89.7)	1,176 (88.7)	1,997 (88.7)	899 (85.9)	0.067
Hypertension	245 (77.0)	383 (73.9)	1,052 (77.4)	765 (74.6)	1,032 (77.4)	1,726 (76.7)	755 (72.2)	0.006
Hyperglycemia	248 (78.0)	410 (79.2)	1,124 (82.7)	833 (81.2)	1,104 (82.8)	1,867 (82.9)	870 (83.2)	0.121
Hypertriglyceridemia	207 (65.1)	365 (70.5)	946 (69.6)	701 (68.3)	890 (66.8)	1,478 (65.7)	695 (66.4)	0.139
Low high-density lipoprotein cholesterol	202 (63.5)	337 (65.1)	881 (64.8)	661 (64.4)	812 (60.9)	1,448 (64.3)	684 (65.4)	0.383
Current smoker	514 (29.4)	709 (21.8)	1,701 (20.9)	1,488 (20.2)	2,141 (24.3)	2,738 (18.6)	1,341 (16.2)	<0.001
Gained $\geq$ 10 kg since age 20 y	416 (31.7)	552 (26.4)	1,392 (25.1)	1,261 (24.2)	1,482 (23.8)	2,508 (25.1)	1,305 (21.7)	<0.001
Change weight ($\pm$ 3 kg in a year)	389 (29.7)	572 (27.4)	1,432 (25.9)	1,360 (26.2)	1,602 (25.8)	2,660 (26.7)	1,540 (25.7)	0.046
No exercise habit	1,098 (84.1)	1,696 (81.2)	4,656 (84.2)	4,305 (82.8)	5,020 (90.6)	8,319 (83.6)	4,940 (82.3)	<0.001
Engage in <1 h/day of walking	910 (69.5)	1,433 (68.7)	3,850 (69.7)	3,368 (64.7)	3,665 (58.8)	5,359 (53.9)	3,746 (62.3)	<0.001
Walk at a slower speed	731 (55.9)	1,153 (55.4)	3,315 (60.0)	2,732 (52.8)	3,106 (49.4)	5,449 (54.8)	3,083 (51.3)	<0.001
Eat faster compared to others	372 (28.5)	587 (28.3)	1,446 (26.3)	1,510 (29.3)	1,936 (31.2)	3,423 (35.0)	1,865 (31.2)	<0.001
Eat dinner before going to bed	390 (29.7)	501 (24.0)	1,316 (23.8)	1,464 (28.1)	1,932 (31.0)	3,162 (31.8)	1,728 (28.8)	<0.001
Eat after the evening meal	239 (18.2)	355 (17.0)	1,104 (19.9)	877 (16.9)	1,175 (18.9)	2,129 (21.4)	1,117 (18.6)	<0.001
Skip breakfast	321 (24.9)	407 (20.1)	1,007 (18.5)	987 (19.4)	1,377 (22.5)	1,831 (19.0)	1,080 (18.4)	<0.001
Alcohol risk	193 (19.8)	345 (21.2)	795 (19.5)	851 (20.1)	1,101 (23.4)	1,635 (20.9)	1,080 (22.9)	<0.001
Not feel refreshed after a night's sleep	600 (46.0)	906 (43.5)	2,514 (45.5)	2,339 (45.1)	2,798 (45.0)	4,557 (45.9)	2,635 (44.1)	0.100

^a Chi-squared tests were used to compare the differences in the prevalence of health risk and the company size by business type.
BMI, body mass index.

Fig. 2 Results of multilevel analysis showing the odds ratios of having MetS for (A) men and (B) women.

is independently related to MetS. Moreover, we conducted a multilevel logistic regression analysis by adding all lifestyle habits that were significantly related to business type: we added “smoking,” “engage in <1 h/day of walking,” “walk at a slower speed,” “meal before bedtime,” and “skip breakfast” for men, and “smoking” and “gained ≥ 10 kg” for women. For men, the lifestyle habits “engage in <1 h/day of walking,” “walk at a slower speed,” and “meal before bedtime” were significantly related to MetS, and a similar association was observed in business type employees in the results of GLMM shown in **Table 5**. Lifestyle habits were significantly related to MetS in women, but no relationship was observed based on business type. This indicates that business type is more as-

sociated with MetS independently in men than in women. Because this study is cross-sectional in nature, additional longitudinal studies are needed to assess the likely causal relationships.

In the current study, we defined MetS based on international criteria. As shown in **Table 4**, the proportion of those with hypertension, hyperglycemia, and hypertriglyceridemia in almost all business types was greater in men, whereas the proportion of those with a large waist circumference was greater in women. However, the proportion of women with hypertension, and hyperglycemia, although less than that for men, was still very high. To prevent MetS, it might be effective to consider the improvement of the access to drug treatment with support

Table 5. Results of the multilevel analysis stratified by sex

Men	Smoking		Engage in <1 h/day of walking		Walk at a slower speed		Meal before bedtime		Skip breakfast		Gained ≥10 kg since age 20 y	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Individual level												
Age (10-year subdivisions)	0.78	(0.77–0.79)	1.04	(1.03–1.06)	0.92	(0.90–0.93)	0.78	(0.76–0.78)	0.60	(0.59–0.61)	1.01	(1.00–1.03)
Company level												
Company size												
1–9	ref		ref		ref		ref		ref		ref	
10–29	1.18	(1.14–1.23)	0.99	(0.94–1.04)	1.05	(1.01–1.10)	1.23	(1.17–1.29)	1.06	(1.01–1.12)	0.93	(0.88–0.99)
30–49	1.14	(1.08–1.21)	1.02	(0.95–1.09)	1.05	(0.99–1.11)	1.31	(1.22–1.40)	1.10	(1.03–1.18)	0.91	(0.87–0.96)
50–99	1.15	(1.09–1.21)	1.10	(1.03–1.18)	1.13	(1.07–1.19)	1.27	(1.18–1.36)	1.11	(1.03–1.19)	0.93	(0.88–0.99)
100–299	1.16	(1.09–1.23)	1.05	(0.98–1.13)	1.10	(1.04–1.17)	1.33	(1.23–1.43)	1.12	(1.04–1.21)	0.97	(0.93–1.02)
Business type												
Transportation	ref		ref		ref		ref		ref		ref	
Construction	0.88	(0.82–0.94)	0.59	(0.54–0.65)	0.84	(0.78–0.91)	1.00	(0.91–1.09)	0.70	(0.64–0.77)	1.05	(0.98–1.14)
Manufacturing	0.61	(0.57–0.65)	0.79	(0.73–0.86)	0.86	(0.80–0.92)	0.62	(0.57–0.67)	0.52	(0.47–0.56)	0.72	(0.67–0.77)
Information and communication	0.47	(0.41–0.52)	0.83	(0.72–0.95)	0.66	(0.59–0.75)	0.79	(0.69–0.91)	0.65	(0.56–0.75)	1.09	(0.96–1.13)
Wholesale trade	0.61	(0.57–0.66)	0.64	(0.58–0.69)	0.67	(0.62–0.72)	0.85	(0.78–0.93)	0.71	(0.65–0.77)	0.86	(0.80–0.93)
Services	0.66	(0.62–0.71)	0.56	(0.51–0.61)	0.68	(0.64–0.74)	0.75	(0.69–0.82)	0.76	(0.70–0.83)	0.80	(0.74–0.86)
Healthcare	0.41	(0.38–0.45)	0.54	(0.49–0.60)	0.70	(0.64–0.77)	0.56	(0.50–0.63)	0.46	(0.41–0.51)	0.73	(0.67–0.80)
Others	0.48	(0.45–0.51)	0.72	(0.66–0.79)	0.69	(0.64–0.75)	0.73	(0.67–0.80)	0.55	(0.51–0.61)	0.95	(0.88–1.02)

Table 5. Results of the multilevel analysis stratified by sex (continued)

Women	Smoking		Engage in <1 h/day of walking		Walk at a slower speed		Meal before bedtime		Skip breakfast		Gained ≥10 kg since age 20 y	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Individual level												
Age (10-year subdivisions)	0.78	(0.76–0.80)	0.95	(0.92–0.97)	0.79	(0.77–0.81)	0.86	(0.83–0.89)	0.75	(0.72–0.77)	1.20	(1.16–1.23)
Company level												
Company size												
1–9	ref		ref		ref		ref		ref		ref	
10–29	1.13	(1.05–1.22)	1.05	(0.98–1.13)	1.15	(1.08–1.23)	1.15	(1.07–1.24)	1.14	(1.05–1.24)	1.05	(0.97–1.13)
30–49	1.26	(1.15–1.38)	1.00	(0.91–1.09)	1.07	(0.98–1.16)	1.31	(1.19–1.44)	1.22	(1.10–1.35)	1.06	(0.97–1.16)
50–99	1.43	(1.31–1.56)	1.05	(0.96–1.14)	1.16	(1.07–1.25)	1.33	(1.22–1.45)	1.24	(1.13–1.37)	1.14	(1.05–1.24)
100–299	1.35	(1.23–1.49)	1.04	(0.95–1.14)	1.20	(1.10–1.29)	1.33	(1.21–1.46)	1.20	(1.08–1.34)	1.12	(1.03–1.22)
Business type												
Transportation	ref		ref		ref		ref		ref		ref	
Construction	0.75	(0.64–0.88)	0.95	(0.80–1.12)	1.05	(0.90–1.22)	0.78	(0.66–0.93)	0.81	(0.67–0.98)	0.78	(0.67–0.92)
Manufacturing	0.60	(0.52–0.70)	0.96	(0.82–1.11)	1.18	(1.03–1.35)	0.73	(0.62–0.85)	0.68	(0.57–0.80)	0.72	(0.62–0.82)
Information and communication	0.60	(0.46–0.78)	0.90	(0.70–1.17)	0.88	(0.69–1.10)	1.22	(0.95–1.58)	0.97	(0.74–1.29)	0.76	(0.59–0.98)
Wholesale trade	0.62	(0.53–0.72)	0.79	(0.68–0.92)	0.88	(0.77–1.00)	0.94	(0.81–1.10)	0.73	(0.62–0.86)	0.70	(0.61–0.81)
Services	0.75	(0.65–0.87)	0.64	(0.55–0.75)	0.82	(0.72–0.94)	1.07	(0.92–1.24)	0.92	(0.79–1.09)	0.66	(0.57–0.76)
Healthcare	0.51	(0.44–0.58)	0.49	(0.43–0.57)	0.95	(0.83–1.08)	1.09	(0.95–1.26)	0.70	(0.59–0.81)	0.71	(0.62–0.81)
Others	0.48	(0.41–0.55)	0.71	(0.61–0.83)	0.84	(0.73–0.96)	0.94	(0.81–1.09)	0.69	(0.59–0.81)	0.61	(0.53–0.70)

OR, odds ratio; CI, confidence interval

Table 6. Relation between metabolic syndrome and lifestyle habits (results of the multilevel analysis stratified by sex)

Men	Smoking		Engage in <1 h/day of walking		Walk at a slower speed		Meal before bedtime		Skip breakfast		Gained ≥10 kg since age 20 y	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Each lifestyle habits	1.00	(0.97–1.04)	1.30	(1.25–1.36)	1.24	(1.19–1.29)	1.12	(1.08–1.17)	1.05	(1.01–1.10)	3.50	(3.35–3.66)
Business type												
Transportation	ref		ref		ref		ref		ref		ref	
Construction	0.84	(0.79–0.90)	0.91	(0.84–0.98)	0.88	(0.81–0.96)	0.88	(0.81–0.95)	0.88	(0.81–0.96)	0.86	(0.79–0.93)
Manufacturing	0.66	(0.62–0.70)	0.66	(0.62–0.71)	0.66	(0.61–0.70)	0.66	(0.62–0.71)	0.66	(0.61–0.71)	0.70	(0.65–0.75)
Information and communication	0.83	(0.73–0.95)	0.88	(0.76–1.02)	0.89	(0.77–1.03)	0.88	(0.76–1.01)	0.88	(0.76–1.02)	0.85	(0.73–0.99)
Wholesale trade	0.77	(0.72–0.82)	0.82	(0.76–0.89)	0.81	(0.75–0.88)	0.80	(0.75–0.86)	0.81	(0.75–0.87)	0.82	(0.76–0.89)
Services	0.74	(0.69–0.78)	0.77	(0.72–0.83)	0.75	(0.70–0.81)	0.75	(0.70–0.81)	0.74	(0.69–0.80)	0.78	(0.72–0.84)
Healthcare	0.78	(0.72–0.85)	0.78	(0.70–0.86)	0.76	(0.68–0.84)	0.76	(0.69–0.84)	0.76	(0.69–0.85)	0.81	(0.73–0.90)
Others	0.77	(0.73–0.83)	0.80	(0.74–0.86)	0.79	(0.73–0.85)	0.78	(0.73–0.84)	0.78	(0.72–0.84)	0.77	(0.71–0.84)
Women												
Business type	Smoking		Engage in <1 h/day of walking		Walk at a slower speed		Meal before bedtime		Skip breakfast		Gained ≥10 kg	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Each lifestyle habits	1.22	(1.14–1.30)	1.25	(1.18–1.33)	1.41	(1.33–1.50)	1.12	(1.05–1.20)	1.05	(0.97–1.14)	6.13	(5.73–6.56)
Business type												
Transportation	ref		ref		ref		ref		ref		ref	
Construction	0.83	(0.71–0.99)	0.82	(0.68–1.00)	0.82	(0.67–1.00)	0.83	(0.68–1.01)	0.83	(0.68–1.01)	0.89	(0.72–1.11)
Manufacturing	0.89	(0.77–1.03)	0.90	(0.76–1.06)	0.89	(0.75–1.05)	0.91	(0.77–1.08)	0.91	(0.76–1.08)	1.03	(0.86–1.24)
Information and communication	0.80	(0.59–1.08)	0.88	(0.63–1.22)	0.87	(0.61–1.22)	0.87	(0.62–1.22)	0.88	(0.62–1.24)	0.98	(0.67–1.42)
Wholesale trade	0.81	(0.69–0.94)	0.81	(0.68–0.96)	0.81	(0.68–0.96)	0.81	(0.68–0.96)	0.82	(0.69–0.97)	0.91	(0.76–1.11)
Services	0.76	(0.65–0.87)	0.78	(0.66–0.92)	0.77	(0.65–0.92)	0.76	(0.65–0.90)	0.77	(0.65–0.91)	0.90	(0.74–1.08)
Healthcare	0.85	(0.74–0.98)	0.87	(0.74–1.02)	0.85	(0.72–1.00)	0.85	(0.72–1.00)	0.86	(0.73–1.01)	0.96	(0.81–1.15)
Others	0.72	(0.62–0.84)	0.70	(0.59–0.83)	0.71	(0.59–0.84)	0.70	(0.59–0.83)	0.70	(0.59–0.84)	0.82	(0.68–0.99)

Adjusted by age, company size, and business type.

of improving lifestyle habits.

There are several limitations of our study. First, although the business type was clear, the participants' roles in the businesses were unclear. For example, in the transportation industry, there are not only drivers, but also office clerks and sales representatives. Different job types may have differences in sedentary time, the manner of eating, and sleeping time. Because the current findings reveal poor health habits and a high prevalence of MetS among transportation workers, further studies should investigate these findings by job type among workers in the transportation industry. Second, the findings of this study may be confounded by unobserved environmental-level factors, such as family and neighborhood factors, regional factors, and socioeconomic status. Third, there is a possibility of selection bias, because only workers who attended the checkups (43.1%) were included. Therefore, it is possible that more health-conscious workers tended to participate in the study, suggesting that the real prevalence of MetS might be higher than that recorded here because of non-participation bias. Fourth, lifestyle habits were evaluated via a self-administered questionnaire. Consequently, these subjective results might be different from the participants' actual lifestyle habits. Despite these limitations, the results of this study are still important: this large-sample study focusing on SMEs suggests that an environmental approach might be useful to prevent MetS in transportation workers. Furthermore, the multilevel analysis showed the effects of business type as an environmental influence in consideration of individual lifestyle habits.

In conclusion, the prevalence of MetS and related unhealthy lifestyle habits were higher in transportation workers than in workers from other business types. The current findings illustrate that the prevalence of MetS and associated lifestyle risk factors vary according to business type and sex. These findings should be considered when developing an environmental approach to improve public health.

Acknowledgments

This study was funded by the Keio University Doctorate Student Grant-in-Aid Program. We are grateful to the health insurance association and all workers who provided invaluable data.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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