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Original Article

Prevalence of coronary heart disease and its risk factors by working environment among Japanese male workers

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Abstract: Work is a major social determinant of health. We conducted a cross-sectional study to explore the association between coronary heart disease (CHD), its risk factors, and the working environment among Japanese male workers. We collected data from 10,572 workers (mean age 49.9 yr) who underwent annual medical check-ups in Toyama, Japan, in 2016. This study included data from health check-ups and questionnaires on medical history of CHD, hypertension, and diabetes, and the use of medication. The working environment included company size and industry categories. Company size was classified into 4 categories according to the number of full-time workers (1–20, 21–100, 101–300, 301–). The industry category was classified into 10 categories. Logistic regression analysis was performed to explore the association. In total, 1.5% of patients had a history of CHD and 31.5% and 11.0% of participants were suffering from hypertension and diabetes, respectively. Compared to workers in a large company, those in a smaller company were more likely to have CHD. Moreover, there was a significant association between CHD's risk factors and working in the transportation industry. Health providers, including medical doctors, should consider employee working environment as a potential risk factor for CHD.

Key words: Cardiovascular, Coronary heart disease, Hypertension, Diabetes, Company size, Industry category

Introduction

Coronary heart disease (CHD), which includes myocardial infarction and angina pectoris, is the leading cause of morbidity and mortality in developed countries[1)]. Heart disease, including CHD and heart failure, results in serious illness, disability, and decreased quality of life. In Japan, heart disease is the second leading cause of death, following cancer, accounting for 15.3% of deaths in 2018[2)]. Because most cases of heart failure are caused by CHD, disease prevention in the younger generation is crucial. In addition to the traditional CHD risk factors such as hypertension, diabetes, obesity, and unhealthy lifestyles, it is important to identify other risk factors such as psychological and socioeconomic factors.

Occupation provides individuals with the means for living and influences socioeconomic status and health behaviors such as smoking, diet, physical activity, and psychological distress[3)]. To date, inequalities in health attributable to work-related factors have been reported in the public health sector worldwide, particularly in Western countries[4–7)]. Work-related factors that have been

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associated with CHD are occupational grade and stressful workplace[5, 8]. Lower occupational grade, including blue-collar and unskilled manual workers, and workplaces with high demand or low control were associated with the prevalence, incidence, and mortality of CHD[3, 5].

However, other work-related factors such as company size and industry categories have not been fully surveyed. Because workers within the same industry are likely to have similar lifestyles and health behaviors[9], clarifying the association between these work-related factors and CHD can aid in understanding the other background factors affecting CHD.

The prevalence of CHD and its traditional risk factors such as hypertension and diabetes differ depending on the working environment, including company size and industry categories, because working time and work-related stress may differ according to business stability and social needs in this rapidly changing society with a stagnant economy in Japan. Our previous study showed the age-adjusted mortality rates of Japanese male workers between 1965 and 1995, and found that the mortality rate due to ischemic heart disease was higher in transportation and service workers than in other occupational groups[10]. We hypothesized that the health differences by working environment or poor health in the transportation industry would persist because of a surge in electronic commerce, such as online shopping and shipping, since 2010. Therefore, we aimed to explore the association between CHD, its risk factors, and the working environment among the general population of male workers in Japan.

Methods

Study design and participants

This was a large-scale cross-sectional study using health check-up data. Under the Industrial Safety and Health Law of Japan, all employers are required to perform medical check-ups of all employees at least once a year. The participants in this study were male workers who underwent an annual health check-up at a hospital in Toyama, Japan, in 2016. The prevalence of CHD in female is low and the actual number of female workers with CHD in this study was only 17 out of 6,000 participants (=0.3%). Due to the small statistical power, we analyzed only male workers. We collected data from 10,572 male workers aged 30–75 yr to assess the prevalence of CHD and its risk factors. Workers younger than 30 yr were also excluded from our study due to the low prevalence of CHD.

This study was approved for academic purposes by the Ethics Committee of University of Toyama (R2019107). The data we received had already been de-identified. Consent was obtained via the opt-out approach.

Measurements

Anthropometric, blood pressure (BP), and blood sampling

Height and weight were measured, and body mass index (BMI) was calculated as weight (kg) divided by the square of height (m). Right brachial BP was measured by well-trained nurses while the participants were seated, after at least 5 min of rest, using an automated sphygmomanometer. All blood samples were collected in a fasting state. Serum total cholesterol, triglycerides (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL) cholesterol, glucose, and hemoglobin A1c (HbA1c) levels were measured. Fasting conditions were confirmed by inquiries (>10 h without a meal). Hypertension was defined as a systolic pressure ≥140 mmHg, diastolic pressure ≥90 mmHg, or the use of antihypertensive drugs, according to the guidelines in Japan[11]. Diabetes was defined as a fasting glucose level ≥126 mg/dl, HbA1c (NGSP) ≥6.5%, or the use of antihyperglycemic drugs. Dyslipidemia was defined as TG ≥140 mg/dl, LDL cholesterol level ≥140 mg/dl, HDL cholesterol level <40 mg/dl, or the use of antihyperlipidemic drugs.

Questionnaire on lifestyle and current and past medical history

Smoking habits, diet, physical exercise, and sleep habits were assessed using a self-administered questionnaire, which is the standard questionnaire used in specific health check-ups in Japan[12]. Dietary questionnaires included, "Do you have an evening meal within 2 h before bedtime 3 d or more per week?" and "Do you eat snacks after the evening meal 3 d or more per week?" Physical exercise was assessed using two inquiries: "Have you been exercising at least 2 d per week, at least 30 min each at an intensity that causes a slight sweat, for at least 1 yr?" and "Do you walk for at least 1 h every day or have equivalent physical activities in your daily life?" The questionnaire for sleep habits included: "Do you feel refreshed after a night's sleep?" Except for smoking habits (current smoker, past smoker, or never smoker), all the responses were answered in the "yes" or "no" format. Regarding physical exercise, answering "yes" in either inquiry was defined as having an exercise habit. We also inquired about the current and past medical history of CHD (angina pectoris and myocardial infarction), hypertension, diabetes, and dyslipidemia. The answers to the medical history questions were dichoto-

mized as "yes" or "no".

Working environment

The company size was based on the number of full-time workers. Referring to previous studies and the governmental categorization of small- and medium-sized companies[13–15], we divided the workers into four categories (1–20, 21–100, 101–300, and 301–).

Company industry was categorized according to the Japan Standard Industry Classification[16], which is compatible with the North American Industry Classification System[17], based on 20 categories (from A: Agriculture and Forestry, to T: unclassified). We only used 10 categories: manufacturing; agriculture, forestry, and fishing; construction; utilities; transportation; wholesale trade; professional services; health care; other services; and public administration. Other business categories such as mining, information, and finance were excluded because the number of workers was small (<90), due to the low prevalence of CHD in our study.

Statistical analysis

Participant characteristics were collected and the proportion of categorical data and the mean and standard deviation (SD) of BMI and age were calculated (Table 1). We then assessed the distribution of unhealthy lifestyles by work environment (Table 2). The association between a medical history of CHD and working environment was assessed using multivariable logistic regression analysis (Table 3). Adjusted odds ratios (aOR) and 95% confidence interval (95% CI) were calculated. We employed two models: company size and industry category models. Age, BMI, lifestyle factors, and lifestyle-related diseases, such as hypertension, were included as confounders in both models. Hosmer-Lemeshow goodness-of-fit test showed p=0.222 in the company size model and p=0.430 in the industrial category model, meaning good fit in these analyses. After learning that hypertension and diabetes were significantly associated with CHD, we explored the association between these two diseases and the working environment (Tables 4 and 5), with a p-value <0.05 considered to be significant. Statistical analyses were performed using IBM SPSS Statistics Ver. 25 for Windows (Chicago, IL, USA).

Results

Characteristics of overall participants

Table 1 shows the characteristics of participants with and without missing data. The mean (SD) age of the participants was 49.9 (SD 11.3) yr. In total, 149 (1.5%) patients had a history of CHD and 3,219 (31.5%) and 1,053 (11.0%) were suffering from hypertension and diabetes, respectively. Regarding company size, more than half of the companies were categorized as having 1–20 (15.9%) and 21–100 (43.2%) employees. Regarding the industry category, most participants worked in the manufacturing industry (43.8%), followed by construction (20.4%) and transportation (11.6%).

We demonstrate the distribution of unhealthy lifestyles by company size and industry category in Table 2. Current or past smokers were more prevalent among workers of smaller companies (81.2% in "1–20 employees" and 76.5% in "21–100 employees"). There were no distinctive traits in the other lifestyle habits. Regarding the industry category, transportation workers were more likely to smoke (82.8%), eat dinner within 2 h of bedtime (43.1%), and be inactive (63.8%).

Table 3 shows the prevalence of and factors associated with CHD. A higher prevalence of CHD was observed in smaller companies, compared to those with "301–". In the multivariable analysis (all variables in the table were simultaneously included), company size had a significant or marginal association with CHD (aOR=1.53, 95% confidence interval: 95% CI, 0.69–3.40 for company size "1–20"; aOR=2.02, 95% CI, 1.01–4.02 for "21–100", and aOR=1.74, 95% CI, 0.81–3.76 for "101–300"). The prevalence varied in the industry category model (from 0.7% in agriculture, forestry, and fishing to 3.2% in professional services); however, there was no significant association among the categories in the multivariable analysis. Lifestyle factors such as smoking habits (past smoker) and sleep habits were significantly associated with CHD in both models. Similarly, hypertension and diabetes were significantly or marginally associated with CHD in both models.

Then, we assessed the association of hypertension and diabetes. Table 4 shows the association between hypertension and the working environment. In the industry category model, transportation was associated with hypertension (aOR=1.20, 95% CI, 1.03–1.41). In the company size model, a higher prevalence of hypertension was observed in smaller companies, although this was not significant in the multivariable analysis. In Table 5, diabetes and working environments are analyzed. Although there was no trend in company size, transportation in the industry category model had a significant association with diabetes (aOR=1.32, 95% CI, 1.07–1.65).

Table 1. Basic characteristics of the participants

	Number n=10,572	% without missing	% no missing
Company size (number of employees)			
1–20	1,196	11.3	15.9
21–100	3,251	30.8	43.2
101–300	1,681	15.9	22.4
301–	1,393	13.2	18.5
Missing	3,051	28.9	
Industry category			
Manufacturing	4,348	41.1	43.8
Agriculture, Forestry, and Fishing	327	3.1	3.3
Construction	2,027	19.2	20.4
Utilities	183	1.7	1.8
Transportation	1,153	10.9	11.6
Wholesale trade	745	7.0	7.5
Professional services	112	1.1	1.1
Health care	505	4.8	5.1
Other services (Waste treatment and disposal, electronic and precision equipment repair and maintenance)	382	3.6	3.8
Public administration	156	1.5	1.6
Missing	634	6.0	
BMI			
Continuous variable, mean (SD)	23.8 (3.7)	-	-
Age (30–75 yr)			
Continuous variable mean (SD)	49.9 (11.3)	-	-
Smoking habits			
Current smoker	4,379	41.4	43.1
Past smoker	3,320	31.4	32.7
Never	2,458	23.3	24.2
Missing	415	3.9	
Eat dinner within 2 h before bedtime			
3 times or more / week	4,010	37.9	39.5
Not	6,141	58.1	60.5
Missing	421	4.0	
Eat snacks after dinner			
3 times or more / week	2,494	23.6	24.6
Not	7,660	72.5	75.4
Missing	418	4.0	
Exercise habits			
Yes	4,633	43.8	45.6
Not	5,522	52.2	54.4
Missing	417	3.9	
Sleep habits			
Enough (feeling refreshed after a night's sleep)	6,299	59.6	62.1
Not	3,846	36.4	37.9
Missing	427	4.0	
Hypertension			
No	7,011	66.3	68.5
Yes	3,219	30.4	31.5
Missing	342	3.2	
Diabetes			
No	8,511	80.5	89.0
Yes	1,053	10.0	11.0
Missing	1,008	9.5	
Dyslipidemia			
No	7,001	66.2	68.0
Yes	3,291	31.1	32.0
Missing	280	2.6	
History of coronary heart disease			
No	10,005	94.6	98.5
Yes	149	1.4	1.5
Missing	418	4.0	

BMI: body mass index; SD: standard deviation.

Table 2. Distribution of unhealthy lifestyles by company size and industry category

	Smoking	Eat dinner within 2 h of bedtime	Eat snacks after dinner	Exercise habits	Sleep habits
	Current or past smoker	Yes	Yes	Not	Not enough
Number of employees	%	%	%	%	%
1–20	81.2	36.7	22.9	55.2	33.0
21–100	76.5	40.1	25.1	55.1	38.6
101–300	72.3	45.6	27.8	56.6	48.1
301–	72.1	40.2	25.3	53.8	36.0
χ^2 test	$p<0.001$	$p<0.001$	$p<0.05$	$p=0.499$	$p<0.001$
Industry category	%	%	%	%	%
Manufacturing	70.8	38.9	27.6	54.5	40.1
Agriculture, forestry, and fishing	81.8	43.8	15.3	42.5	35.5
Construction	83.5	39.8	22.9	52.6	32.4
Utilities	78.1	33.0	24.2	52.2	40.1
Transportation	82.8	43.1	20.5	63.8	39.5
Wholesale trade	76.0	43.9	23.4	51.1	39.0
Professional services	69.7	36.6	17.0	71.4	37.3
Health care	65.7	34.8	29.0	48.1	36.4
Other services (Waste treatment and disposal, electronic and precision equipment repair and maintenance)	79.5	37.9	24.7	51.9	40.4
Public administration	70.1	30.8	16.4	52.2	32.8
χ^2 test	$p<0.001$	$p=0.001$	$p<0.001$	$p<0.001$	$p<0.001$

Discussion

The current study revealed a high prevalence of CHD among workers in smaller companies, which was statistically significant in companies with 21–100 employees, and a significant association between hypertension, diabetes, and the transportation industry. To our knowledge, few studies comprehensively assessing CHD, its risk factors, and the working environment have been conducted in Japan. Therefore, our findings provide valuable information that encourages health providers, including medical doctors, to consider working environments as CHD risk factors.

Company size can be used as a proxy for working class. This is because working conditions, including salary, quality industrial health, and safety activities, for employees in large companies have traditionally been better and more stable than those in small companies[18, 19]. To date, many studies have demonstrated the association between working class (e.g., manager, professional, service, and blue-collar) and CHD[20–22]. However, the association between CHD and company size has rarely been explored. In Japan, only one study has explored the association between company size and cardiovascular disease (CVD) mortality[23]. This study showed that employees of small companies (1–29 employees) had a significantly higher hazard ratio in total CVD mortality from a 20 yr follow-up study. Despite the differences in study design, our cross-sectional study showed similar results: workers belonging to smaller companies were more likely to have a higher CHD prevalence. As our study was conducted among a working-age population, health inequality in CHD may have occurred at an earlier stage of life than expected.

Moreover, our study adjusted for traditional risk factors, such as hypertension, diabetes, and unhealthy lifestyles. Therefore, we demonstrated not only the importance of controlling traditional risk factors but also identified other potential mechanisms leading to the association between small companies and CHD in this study. In addition to the finding that lifestyle-related diseases and unhealthy lifestyles are known to be more prevalent in workers of smaller companies than in those in large companies[13, 24], we suggest other factors affecting the development of CHD among workers in small companies. One plausible explanation is the difficulty in accessing health check-ups[14]. Workplaces with 50 employees or more are required to appoint health supervisors and occupational physicians according to the Industrial Safety and Health

Table 3. Prevalence and factors associated with coronary heart disease

	Company size model n=6,814			Industry category model n=8,913		
	Number	Prevalence %	Multivariable aOR (95% CI)	Number	Prevalence %	Multivariable aOR (95% CI)
Number of employees						
1–20	1,107	1.6	1.53 (0.69–3.40)			
21–100	2,946	1.8	**2.02 (1.01–4.02)**			
101–300	1,511	1.5	1.74 (0.81–3.76)			
301–	1,250	0.8	1			
Industry category						
Manufacturing				3,854	1.2	1
Agriculture, forestry, and fishing				298	0.7	0.42 (0.10–1.79)
Construction				1,860	2.0	1.19 (0.76–1.86)
Utilities				178	1.1	0.73 (0.17–3.11)
Transportation				1,060	1.9	1.11 (0.65–1.92)
Wholesale trade				675	1.9	1.24 (0.66–2.35)
Professional services				94	3.2	1.83 (0.54–6.21)
Health care				434	0.9	0.64 (0.22–1.80)
Other services (Waste treatment and disposal, electronic and precision equipment repair and maintenance)				335	2.7	1.14 (0.54–2.40)
Public administration				125	2.4	0.89 (0.26–2.96)
BMI continuous variable			**1.08 (1.03–1.15)**			**1.09 (1.04–1.14)**
Age (30–75 yr)						
Continuous variable			**1.10 (1.08–1.13)**			**1.09 (1.07–1.12)**
Smoking habits						
Current smoker	2,996	0.8	1.13 (0.55–2.34)	3,859	0.8	1.04 (0.55–1.96)
Past smoker	2,235	3.0	**2.60 (1.35–4.99)**	3,002	3.2	**2.72 (1.56–4.76)**
Never	1,583	0.7	1	2,052	0.7	**1**
Eat dinner within 2 h before bedtime						
3 times or more / week	2,745	1.3	0.91 (0.60–1.39)	3,480	1.3	0.84 (0.58–1.22)
Not	4,069	1.6	1	5,433	1.7	1
Eat snacks after dinner						
3 times or more / week	1,704	1.5	1.15 (0.72–1.85)	2,176	1.6	1.02 (0.67–1.55)
Not	5,110	1.5	1	6,737	1.4	1
Exercise habits						
Yes	3,014	1.1	**1**	4,033	1.4	1
Not	3,800	1.9	**1.67 (1.09–2.58)**	4,880	1.7	1.18 (0.83–1.68)
Sleep habits						
Enough	4,133	1.3	**1**	5,533	1.3	1
Not	2,681	1.9	**1.72 (1.16–2.56)**	3,380	2.0	**1.96 (1.38–2.77)**
Hypertension						
No	4,649	0.9	1	5,992	0.9	**1**
Yes	2,165	2.9	1.41 (0.92–2.17)	2,921	3.0	**1.50 (1.03–2.17)**
Diabetes						
No	6,112	1.1	1	7,934	1.2	1
Yes	702	5.0	**1.96 (1.25–3.08)**	979	5.0	**2.01 (1.37–2.95)**
Dyslipidemia						
No	4,525	1.6	1	5,915	1.6	1
Yes	2,289	1.4	0.72 (0.47–2.17)	2,998	1.6	0.84 (0.58–1.20)

OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval; BMI: body mass index.

All variables in the table were simultaneously included in multivariable analysis. Bold indicates the statistical significance, $p<0.05$.

Table 4. Prevalence and factors associated with hypertension

	Company size model n=7,270			Industry category model n=9,550		
	Number	Prevalence %	Multivariable aOR (95% CI)	Number	Prevalence %	Multivariable aOR (95% CI)
Number of employees						
1–20	1,152	32.7	1.03 (0.85–1.25)			
21–100	3,128	30.8	1.03 (0.89–1.21)			
101–300	1,624	28.9	1.09 (0.91–1.31)			
301–	1,366	28.5	1			
Industry category						
Manufacturing				4,205	27.5	1
Agriculture, forestry, and fishing				313	34.8	1.09 (0.83–1.44)
Construction				1,936	34.6	1.02 (0.89–1.16)
Utilities				182	30.8	0.94 (0.66–1.35)
Transportation				1,108	37.3	**1.20 (1.03–1.41)**
Wholesale trade				710	31.4	0.92 (0.76–1.11)
Professional services				110	31.8	0.91 (0.58–1.44)
Health care				489	27.4	0.87 (0.69–1.11)
Other services (Waste treatment and disposal, electronic and precision equipment repair and maintenance)				364	40.1	1.01 (0.79–1.30)
Public administration				133	36.1	**0.62 (0.42–0.92)**
BMI						
Continuous variable			**1.19 (1.17–1.21)**			**1.19 (1.17–1.20)**
Age (30–75 yr)						
Continuous variable			**1.09 (1.08–1.09)**			**1.09 (1.08–1.09)**
Smoking habits						
Current smoker	3,188	26.6	0.98 (0.85–1.14)	4,139	27.5	0.95 (0.83–1.08)
Past smoker	2,299	39.4	**1.18 (1.01–1.38)**	3,089	39.9	1.10 (0.96–1.26)
Never	1,783	25.0	1	2,322	26.5	1
Eat dinner within 2 h before bedtime						
3 times or more / week	2,972	29.7	**1.17 (1.04–1.31)**	3,782	30.7	**1.17 (1.05–1.29)**
Not	4,298	30.6	1	5,768	31.7	**1**
Eat snacks after dinner						
3 times or more / week	1,847	25.3	**0.78 (0.68–0.89)**	2,360	25.8	**0.76 (0.68–0.86)**
Not	5,423	31.9	1	7,190	33.1	1
Exercise habits						
Yes	3,259	28.0	1	4,369	29.7	1
Not	4,011	32.0	1.09 (0.97–1.22)	5,181	32.6	1.06 (0.96–1.17)
Sleep habits						
Enough	4,411	31.0	1	5,928	32.1	1
Not	2,859	29.0	0.94 (0.84–1.06)	3,622	30.0	0.95 (0.86–1.06)

OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval.

All variables in the table were simultaneously included in multivariable analysis. Bold indicates the statistical significance, $p<0.05$.

Act in Japan[19, 25]. Therefore, workers in large companies have easier access to medical staff than those in smaller companies. Psychological distress also seems to be greater for workers in smaller companies during a stagnant economy. In addition to the traditional risk factors for CHD, these working factors should also be considered by health providers.

CHD prevalence among industry categories in our study was relatively high in the construction (2.0%), transportation (1.9%), wholesale trade (1.9%), professional services (3.2%), and public administration (2.4%) industries (Table 3). However, the total number of workers with a history of CHD (outcome number) was small in our study, and no significant association was observed between CHD and

Table 5. Prevalence and factors associated with diabetes

	Company size model n=6,818			Industry category model n=8,920		
	Number	Prevalence %	Multivariable aOR (95% CI)	Number	Prevalence %	Multivariable aOR (95% CI)
Number of employees						
1–20	1,109	11.3	0.95 (0.72–1.26)			
21–100	2,948	10.2	0.94 (0.74–1.19)			
101–300	1,511	10.0	1.06 (0.81–1.38)			
301–	1,250	10.1	1			
Industry category						
Manufacturing				3,857	9.1	1
Agriculture, forestry, and fishing				298	11.1	0.94 (0.63–1.41)
Construction				1,862	11.8	0.96 (0.79–1.16)
Utilities				178	9.6	0.83 (0.48–1.44)
Transportation				1,060	14.4	**1.32 (1.07–1.65)**
Wholesale trade				675	12.0	1.10 (0.84–1.44)
Professional services				94	13.8	1.17 (0.62–2.22)
Health care				436	11.7	1.15 (0.82–1.61)
Other services (Waste treatment and disposal, electronic and precision equipment repair and maintenance)				335	13.4	0.84 (0.59–1.19)
Public administration				125	15.2	0.86 (0.51–1.46)
BMI						
Continuous variable			**1.21 (1.18–1.24)**			**1.20 (1.18–1.22)**
Age (30–75)						
Continuous variable			**1.09 (1.08–1.10)**			**1.09 (1.08–1.10)**
Smoking habits						
Current smoker	2,996	9.3	1.17 (0.92–1.47)	3,860	9.9	**1.22 (1.00–1.49)**
Past smoker	2,236	13.2	1.09 (0.86–1.37)	3,004	13.9	1.11 (0.91–1.36)
Never	1,586	8.2	1	2,056	8.7	1
Eat dinner within 2 h before bedtime						
3 times or more / week	2,746	10.3	1.15 (0.97–1.36)	3,482	10.7	1.07 (0.92–1.24)
Not	4,072	10.3	1	5,438	11.2	1
Eat snacks after dinner						
3 times or more / week	1,705	9.7	1.01 (0.83–1.23)	2,177	10.8	1.12 (0.95–1.33)
Not	5,113	10.5	1	6,743	11.1	1
Exercise habits						
Yes	3,015	9.0	**1**	4,036	10.1	1
Not	3,803	11.4	**1.22 (1.03–1.44)**	4,884	11.7	1.12 (0.97–1.29)
Sleep habits						
Enough	4,134	10.7	**1**	5,536	11.3	1
Not	2,684	9.8	0.92 (0.77–1.10)	3,384	10.6	0.97 (0.84–1.13)

OR, odds ratio; aOR, adjusted odds ratio; CI, confidence interval; BMI: body mass index.

All variables in the table were simultaneously included in multivariable analysis. Bold indicates the statistical significance, $p<0.05$.

industry category after adjusting for traditional factors such as hypertension, diabetes, and lifestyle. Several studies in the U.S. and Japan have shown a higher mortality rate among transport and service workers due to ischemic heart disease[10, 26, 27], using the national census or big data. However, these studies did not adjust for traditional risk factors because information on lifestyle and lifestyle-related diseases was not available. In the future, studies with a larger number of workers with CHD and traditional risk factors are needed to clarify the association between industry category and CHD.

We demonstrated that workers in the transportation industry were more likely to smoke, eat dinner within two hours of bedtime, and be inactive (Table 2). Our results

are consistent with those of a previous Japanese study. Hozawa *et al.* showed that male workers in the transportation industry were more likely to have unhealthy lifestyles such as smoking, walking less, eating before bedtime, and skipping breakfast[28]. Furthermore, multivariable analysis in our study revealed a significant association between hypertension and diabetes with working in the transportation industry (Tables 4 and 5). Even after adjusting for lifestyle, transportation had higher aORs for both hypertension and diabetes. Our findings are consistent with those of previous studies[29–31]. These studies also explored the association between industry categories and lifestyle-related diseases such as hypertension, diabetes, and metabolic syndrome in multivariable analyses and found that transportation was significantly associated with a higher prevalence of lifestyle-related diseases. As lifestyle factors were adjusted as confounders, it is conceivable that other factors may play a role in the development of hypertension and diabetes among transportation workers. There are two plausible explanations for the high prevalence of these diseases in the transportation industry. First is the long working duration. According to a governmental survey in Japan, the average working time in the transportation industry (excluding part-time workers) ranked the highest for all industries at 174.7 h per month[32]. Second, the irregularity of working patterns that the transportation business entails. The workload of transportation can vary depending on customer needs, the broader economic situation, and changes in the industry, such as the surge in online shopping and shipping since around 2010, posing challenges to the work schedule of employees in the transportation industry. Moreover, long working hours and irregular work schedule can prevent workers from leading healthy lifestyles, affecting vegetable intake and resting time, which were not adjusted for in our study. As a result, transportation workers may find it more difficult to attend medical appointments within standard working hours than workers in other industries. Physicians or medical practitioners should take these difficulties into consideration and offer transportation workers flexible appointments or longer duration of prescriptions to enable them to manage health-related issues. Further studies on industry categories and health should examine factors such as working time, control over working schedule, and accessibility to medical settings as potential risk factors for lifestyle-related diseases.

This study has several limitations. First, the cross-sectional design did not allow for causal inferences. A prospective study may be more preferable to clarify the influence of working environments on health. Second, although the industry category based on the name of the company is clear, the individual's precise role within the industry is unclear. For example, within a transportation company, there are not only drivers but also office clerks or managers. However, the unclassified roles of individual workers might lessen our findings between industry categories and health. The real associations between transportation, hypertension, and diabetes may be stronger than those we showed. Third, although the company size and industry category were included in our analyses, other work-related factors such as working hours and work-related stresses were not assessed because the health check-up data did not contain information about these factors. In the future, comprehensive information of all work-related factors should be included in the analysis. Fourth, there might be a selection bias because only workers attending health check-ups, reflecting high health consciousness, were included in this study. Furthermore, it is possible that workers with CHD, hypertension, or diabetes already attending hospitals regularly might not have undertaken annual health check-ups. This suggests that the actual prevalence of CHD, hypertension, and diabetes would be higher than that recorded here. Despite these limitations, our findings are still important and suggest that the working environment should also be considered as a potential risk factor for CHD.

Conclusions

Prevalence of CHD was high in small companies, and a significant association was observed between hypertension, diabetes, and the transportation industry. Taking into account working environments can be useful in the prevention of CHD, and health providers, including medical doctors, should consider the working environment as a risk factor for CHD.

Availability of Data and Material

The datasets in the current study are not publicly available because the institution which provided the data did not agree to share the data with the third party. On reasonable request, some of data used in our study are available from the corresponding author.

Conflict of Interest

We declare no competing interest in this article.

Author Contributions

MY and MS collected all data used in this research. MY performed the analyses, interpreted the results, and wrote the manuscript. TT and MS gave technical support, conceptual advice, and critical review. All authors read and approved the final manuscript.

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