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Abstract

Cardiovascular Disease Risk Differences between Bus Company Employees and General Workers According to National Health Insurance Data

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Bus drivers are known to be highly at risk of cardiovascular diseases. In this study, I assessed the cardiovascular disease prevalence of bus company employees and compared the results to those of general workers by analyzing the 2014 Korean National Health Insurance (NHI) data. I defined hypertension, diabetes, dyslipidemia, ischemic heart disease, and cerebrovascular disease based on the KCD-6 medical diagnoses.

The prevalence of five diseases was compared between the bus company employees and the general workers. I also calculated the odds ratios (OR) of five diseases between the two groups. To compensate the vast demographical differences between the two groups, I performed propensity score matching and repeated the analysis.

Bus company employees showed higher prevalence of five diseases than general workers. Bus company employees had higher odds for having hypertension, diabetes mellitus, dyslipidemia and ischemic heart disease than the general workers or propensity score matched controls. Odds of cerebrovascular disease showed inconsistent result between analytic methods.

This study reveals scientific evidence for the needs to implement intensive cardiovascular disease prevention measures for bus drivers. Further studies on the subject with longitudinal design should follow to strengthen the evidence.

keywords : Bus company employees, Commercial drivers, General workers, Cardiovascular disease, National Health Insurance System

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Background

Cardiovascular diseases and related complications are the leading causes of death worldwide and are projected to gradually increase in the near future [1]. An occupation is one of the established risk factors of cardiovascular diseases and death [2]. Confirmed work-related cardiovascular disease cases may be associated with worker's compensation [3]. In 2014, 355 workers were compensated for a work-related disease due to cardiovascular and cerebrovascular diseases in Korea [4].

Commercial drivers are known to carry diverse health problems, such as cardiovascular diseases. Their health problems may be more prevalent and severe than those in other occupational types [5]. Long working hours, shift work, cabin ergonomic factors, loud noise, carbon monoxide, chemical materials, social isolation, and lack of decision-making by the authority are occupational health risk factors of commercial driving [5,6]. Work-related diseases of commercial drivers have been studied in various aspects. The incidence of various diseases like bladder cancer, musculoskeletal diseases, depressive disorder, post-traumatic stress disorder, and cardiovascular diseases is higher in commercial drivers compared to other occupations [7 - 10]. Important risk factors of cardiovascular diseases, such as hypertension, diabetes mellitus and obesity are also more prevalent in commercial drivers [11 - 15].

Drivers who carry passengers are highly at risk of stroke than drivers carrying goods [16]. Bus drivers' cardiovascular health is closely related to public safety and is of high concern because the bus carries relatively large number of passengers at once. Being an exception of the labor standard act that prevents workers from working over 12 hours a day in Korea, investigations on bus drivers in South Korea showed long working hours, which is a considerable risk factor of cardiovascular diseases [17].

However, studies on the actual health status of a relatively large group of commercial bus drivers were limited. I planned to determine cardiovascular disease prevalence and their risks on bus drivers and compared the results to that of general workers using Korean National Health Insurance data. I analyzed bus company employees' data as surrogate participants of bus drivers because the Korean National Health Insurance data contains information on a worker's company only and I cannot determine one's actual job characteristics in the company. This procedure can be admitted as a majority (over 90%) of bus company employees are bus drivers [18]. If I could find significant differences in the disease risks between bus company employee and general working groups, this study may strengthen evidence that can be used to help prevent bus drivers from suffering work-related cardiovascular disease.

Methods

Data source

I used Korean National Health Insurance (NHI) data for this study. Registering the National Health Insurance is mandatory for all residents in Korea and it consequently covers almost 100% of the Korean population [19,20]. All registered members are categorized into five groups: employee group, employee's dependent family group, self-employed group, self-employed member's dependent family group and medical aid beneficiary group [19]. The National Health Insurance System now offers four main databases (DB) to researchers: qualification and contribution DB, health insurance claim DB, health check-up DB, and long-term care insurance DB [20,21]. I used the year 2014 data that was the latest one provided at the time of planning the study. I merged and analyzed the first three databases using the data of members that belonged to the employee group only.

Study participants

I regarded the parent population of the study to be all subscribers of the Korean National Health Insurance System in year 2014. I defined a bus company employee to be any person who registered the National Health Insurance under the intra-city bus companies in Seoul, Korea, in year 2014. A total number of target city bus companies in Seoul was 65. I defined the general working group as any employee who were registered in the NHI under any company at the same time. I defined these 17,197 bus company employees and approximately fourteen million general workers as group A study participants.

I subsequently excluded those who did not receive general health check-up in 2014, which is conducted biannually for office workers and annually for non-office workers. I excluded all participants with missing values in covariates for analysis which are explained in the following section. A total of 15,663 bus company employees and 8,014,277 general workers were enrolled and I set them as group B participants. A graphical explanation of the above process is presented in Figure 1.

Disease definition

I regarded that one has specific disease if the NHI claim outpatient and hospital admission records contain any of the specified KCD-6 codes in its main and secondary diagnosis field two or more times in 2014. I decided to use definition of at least two diagnoses to minimize the misclassification due to misdiagnosis done once and not followed up. I listed the codes that are used in the disease definition of hypertension, diabetes mellitus, dyslipidemia, ischemic heart disease and cerebrovascular disease in the table 1.

I additionally defined the diseases using the health check-up data of 2014. Hypertension is defined if one answered 'yes' to the question asking if the subject had been diagnosed as hypertension by physician and/or if the subject was being treated. One was defined to have hypertension if the systolic blood pressure was same or over 140 mmHg or diastolic blood pressure was same or over 90 mmHg. Diabetes mellitus is defined in the similar way. The subject with positive answer to the question on the diagnosis and/or treatment history and/or fasting plasma glucose of same or over 126 mg/dL were defined to have diabetes mellitus. One is regarded to have dyslipidemia if he or she answered to be diagnosed as dyslipidemia and/or to be being treated. He or she was also regarded to carry dyslipidemia if the lab results suggest the diagnosis as follows: total cholesterol of same or over 240 mg/dL and/or triglycerides being same or over 200 mg/dL and/or HDL cholesterol of same or lower 40 mg/dL and/or the calculated LDL cholesterol being same or more than 160 mg/dL. I did not define ischemic heart disease and cerebrovascular disease using general health check-up data as data of more than a quarter was missing when the diseases were defined in the similar way using reported medical history.

Cardiovascular risk factor definition

I extracted data from the general health check-up database of year 2014 to define cardiovascular risk factors, such as obesity, lack of exercise, smoking, and heavy drinking. I used these variables as covariates in the following analyses and excluded the participant with missing information on any of four above variables when defining group B study participants as mentioned in the preceding paragraphs.

Obesity is defined as having a body mass index (BMI, weight (Kg)/height^2 (m)) above 25 Kg/m^2. Lack of exercise is defined as performing moderate to high-intensity exercises less than 3 times a week. I regarded a participant to be smoking if he or she answered the smoking status question as a current smoker. Heavy drinking is defined as a person who reportedly drink more than 7 glasses of alcoholic beverage in a week.

Propensity Score Matching

Preliminary analysis showed that the demographical status seemed to be vastly different between bus company employees and general workers from the group B. Gender and age distribution as well as income level quartile levels are the examples. I used propensity score matching technique to define a comparison group additionally from the general working group, to cover the forementioned differences in covariates. The propensity score is defined as the inverse subject probability of receiving a treatment or being in a certain condition. The propensity score is estimated by using a multinomial logistic model on confounding factors between treatment and outcome [22,23]. Then, the propensity score (matched, adjusted, or weighted) could be considered to estimate the distribution of effects in treated and untreated subjects [22-24].

In this case, the condition is defined to be 'currently working in a bus company'. I performed a logistic regression analysis to estimate the propensity score. I included seven variables such as sex, age group, income level, obesity, smoking, heavy drinking, and lack of exercise in the propensity score model. For each person in the bus company employee group, three participants with the most similar propensity score were selected from the general working group. I used greedy matching algorithm with eight digits. I chose one to three matching because one to four matching yielded statistically significant different characteristics in some variables between two groups while one to three matching showed no significantly different characteristic.

Data analysis

I reviewed demographics of bus company employee group and general worker group from both group A and B study participants. I checked demographic feature of the propensity score matched controls to confirm that there was no statistically different characteristics when compared to those of the bus company employees. I calculated the simple prevalence of each disease in the bus company employee's and general working group from both study participant groups and in the propensity score matched control group. The prevalence using disease definition according to the general health check-up data was also derived. The odds ratios (ORs) of five diseases were calculated as follows. I performed The logistic regression analysis using the following three models: a crude model, an adjusted model 1 which used age groups and sex an covariates and an adjusted model 2 which used all available variables such as age groups, sex, income level quartiles, and cardiovascular disease risk factors like obesity, lack of exercise, smoking status, and heavy drinking as covariates. I calculated the ORs of five diseases for bus company employee group and propensity score matched group using McNemar tests.

I performed the sensitivity analyses to check if the results varied according to the disease definitions and sub-groupings. I analyzed the same data using five sets of disease definition as follows: if one was diagnosed same or more than 1 time, if one was diagnosed same or more than 2 times (this definition is used in the main analyses), if one was diagnosed same or more than 3 times, if one was diagnosed same or more than 6 times and if one was diagnosed same or more than 12 times. Sub-groupings were done as follows: confining the subjects' sex to be male, confining subjects' ages to range between 40 and 59 and confining subjects' income level quartile to be in the third quartile. Male sex, ages from 40 to 59 and the third income level quartile are the dominant traits of the bus company employees.

SAS 9.4 and Microsoft Excel 2016 were used for all statistical analyses. The statistical significance level was set to p-value lower than 0.05.

Results

Table 2 shows the general characteristics of bus company employees and general workers from group A participants that including every participants not excluding the participants without the general health check-up data. About 95.3% and 62.0% of the bus company employee group and general working group each were males. The dominant age groups were 50-59 and 40-49 in the bus company employees and 30-39 and 40-49 in the general workers. It means that the bus company employees were generally older. About 80.1% of the bus company employees were in the third quartile based on the income level. All four characteristics were different between two groups with the p-value below 0.0001.

Table 3 presents the general characteristics of bus company employees and general workers of group B participants which excluded the ones without the general health check-up data or having missing values in the covariates. Around 96.1% and 63.9% of the bus company employee and general working groups were males. Age distribution is similar to the result of Table 2. About 82.1% of the bus company employees were in the third income level quartile. Obesity were more prevalent in the general working group than in the bus company employee group, with 66.3% and 41.1% obese individuals in each group, respectively. About 24.5% and 53.4% of the bus company employee and general working groups were active smokers; 19.1% and 17.0% of bus company employees and general workers were heavy drinkers, respectively; and 38.1% and 61.3% of the bus company employee and general working groups lack adequate exercise, respectively. All seven characteristics were different between two groups with the p-value below 0.0001.

Table 4 shows the general characteristics of bus company employees from group B participants and the propensity score matched controls. A total of 46,989 controls were selected from the general working group. The demographic characteristics between the two groups were similar, as they were matched to be same as to possible extents

Table 5 presents five cardiovascular diseases' prevalence between the bus company employees and general workers from the group A participants. The prevalence of all five diseases was higher in the bus company employee group than that in the general working group. All p-values were below 0.0001.

Table 6 are about the five diseases' prevalence between the bus company employees and general workers from group B participants and propensity score matched controls. The prevalence of all five diseases was higher in the bus company employee group than that in the general working group or the matched control group. Every p-value being below 0.05 showed the statistical significant differences.

Table 7 shows the prevalence of three diseases defined by the general health check-up data. All three diseases' prevalence was higher in the bus company employee group with statistical significance. When compared with the previous disease definition as in Table 5 and 6, the prevalence in Table 7 generally shows higher values. The prevalence of dyslipidemia is especially higher showing up to approximately five times higher percentage.

In Table 8, 9, 10 and 11, I presented various odds ratios for cardiovascular diseases of bus company employees. In Table 8, ORs by the crude model for having cardiovascular diseases of bus company employees compared to those of general workers from the group A participants were all over one in all diseases with significance. When I made the adjustment with age groups and sex, ORs of hypertension (1.81, 95% CI: 1.75-1.88), diabetes (1.51, 95% CI: 1.43-1.58), dyslipidemia (1.99, 95% CI: 1.91-2.07) and ischemic heart disease (1.21, 95% CI: 1.12-1.32) remained significantly over one. The OR of cerebrovascular disease (1.04, 95% CI: 0.92-1.17) became non-significant.

Similar results can be seen in Table 9. In the fully adjusted model in Table 9, which is the result of analyzing the group B participants, ORs for hypertension (1.79, 95% CI: 1.72-1.85), diabetes (1.57, 95% CI: 1.49-1.65), dyslipidemia (1.96, 95% CI: 1.88-2.04) and ischemic heart disease (1.30, 95% CI: 1.19-1.42) were over one with the similar OR values to those of Table 8. OR of cerebrovascular disease (1.09, 95% CI: 0.96-1.23) showed non-significant result.

The propensity score matched model presented in Table 10 yielded significantly higher odds of cerebrovascular disease (OR 1.17, 95% CI: 1.01-1.35) in the bus company employee group. The other diseases showed consistent results. ORs for hypertension (1.58, 95% CI: 1.51-1.64), diabetes (1.49, 95% CI: 1.40-1.59), dyslipidemia (1.91, 95% CI: 1.82-2.01) and ischemic heart disease (1.31, 95% CI: 1.18-1.45) were in the positive directions.

Table 11 shows contrasting results. The ORs of three diseases in the crude model were in the positive direction. In the fully adjusted model, however, showed more neutralized value of ORs than the other tables. The Odds of diabetes (OR 1.04, 95% CI: 1.00-1.10) became marginally not significant. The ORs of hypertension (1.11, 95% CI: 1.08-1.16) and dyslipidemia (1.03, 95% CI: 1.00-1.07) retained the statistical significance with posiutive relations.

I presented the results of the sensitivity analyses In Table 12 to 15. In Table 12, all ORs of hypertension, diabetes and dyslipidemia remain significantly over one regardless of the disease definition although the OR values had tendency to increase as the disease definition with more frequent diagnosis was used. The odds of having ischemic heart disease showed non-significant result (OR 1.03, 95% CI: 0.94-1.12) only when the loosest definition is used. The rest definitions yielded positive relations. The Odds of having cerebrovascular disease showed negative relationship (OR 0.81, 95% CI: 0.72-0.92) when only one diagnosis was needed to define the disease. While the ORs remained non-significant in 2 times or 3 times diagnosis definitions, ORs became significantly over one in the other two definitions. When I confined my data to male subjects only, the results were similar to the previous results of the main analysis as one can see in Table 13. Four diseases showed positively directed odds, while only cerebrovascular disease showed non-significant result. Participants were subgrouped into the same age range in Table 14 and the same income level quartile in Table 15. Table 14 and 15 shows the results that bus company employee subgroups have statistically significant positive odds of having all five diseases.

Discussion

I found that bus company employees have higher odds of having hypertension, diabetes mellitus, dyslipidemia and ischemic heart disease when compared to general workers or propensity score matched controls. These results were consistent with the previous studies as bus drivers, who are the majority of bus company employees, have occupational risk factors of cardiovascular diseases [6,9,10]. The odds of bus company employees having cerebrovascular disease showed non-significant results when compared to general workers after adjusting all covariates. On the other hand, odds of bus company employees having cerebrovascular disease resulted in positive relationship in the propensity score matched model.

The mechanisms of these associations could be explained as follows. Stress in commercial bus driving may cause negative neuro-physiological effects as driving can be conceptualized as a kind of threat avoidance task [25,26]. Driving can actually promote cardiovascular risk markers. It is reported that one's blood pressure and pulse rate were elevated during driving [25]. Bus drivers are continuously exposed to outdoor air during work hours. The fact that long term exposure of air pollution, especially particulate matter (PM), increase the cardiovascular morbidity and mortality has strong scientific evidences [27].

One might assume that bus drivers may execute worse health behaviors. This assumption, however, was not supported in this study population as self-reported health behaviors like smoking and lack of exercise were more prevalent in the general population than the bus company employees. The other reason which can be considered is the fact that the average age was significantly higher in the bus driver group than that in the general population. Therefore, I used statistical adjustment of age groups and propensity score matching to compensate the vast effects of age on the target diseases' prevalence.

In Korea, the working hours are legally limited to same or below 40 hours per week, which can be extended up to 52 hours when there is an agreement between an employee and an employer. In certain industries, including bus transportation, exceptions existed at this regulation. There is a report that average daily working hours of Korean bus drivers are from 11 hours to 18 hours [17]. It has been studied that long working hours are associated with increased risks of cardiovascular diseases [28-31]. I cannot conclude that this association in this study is generally applicable because there is no information on working hours. However, it is possible that long working hours in bus drivers could be additional burden to hypertension, diabetes and dyslipidemia

The inconsitent relationship of cerebrovascular diseases are thought to caused by the relatively severe consequences of the diseases. Those with history of the disease are likely to have worse health conditions and not to be capable of driving, especially a special vehicle like bus. This may cause a kind of healthy worker effect, diminishing the current prevalence of the disease [32]. Previous bus drivers who experienced cerebrovascular disease might have not been able to return to work [33]. Cerebrovascular disease showed significant positive relationship In the sensitivity analysis using disease definition of more frequent diagnoses (six times and twelve times). This might mean that bus company employee have less mis-diagnosed cerebrovascular diseases, or having more severe consequences of the diseases which require frequent treatment and examination by physicians.

The current study exhibits a few novel findings. The fact that bus drivers have higher risk of having cardiovascular disease and hypertension is well known. However, to my knowledge, this is the first epidemiologic study to show the bus company employees' higher odds of having other cardiovascular risk factors like diabetes mellitus and dyslipidemia. These facts could broaden our understanding on the multiple pathway of cardiovascular health effect of bus driving as an occupation.

Previous studies have explained that some portion of occupational health risk of commercial bus driving is due to worse life style factors of bus drivers such as smoking, excessive alcohol drinking, insufficient exercise and obesity [10,34]. I found out that bus company employees actually have better life style in some aspects. While obesity and heavy alcohol drinking are more prevalent in bus company employees, the percentage of current smokers and ones with lack of physical activities were lower in the bus company employee group. These findings imply that independent occupational risk factors of bus driving other than life style might have worse influence on cardiovascular health than previously reported.

Additionally, there has been no large scale epidemiologic study on the bus drivers' cardiovascular health in Korea. Number of the participants in the previous studies in Korea was below 500 which is not enough to strongly assert the detrimental effect on health of commercial bus driving [6.35]. Although the overall results are in line with previous researches, this study has the strength in that it utilized almost whole working population and every intra-city bus company employees in Seoul.

This study has several limitations. First, the Korean National Health Insurance data only contain the company information which a worker is registered. A researcher could not infer a worker's actual job characteristics based on the company's information as workers may have various job characteristics in one company. Although most employees of the bus companies (>90%) are bus drivers as mentioned earlier [18], we could not ensure the absence of bias caused by non-driving employees. Non-driving employees could be bus mechanic or administrative personnel. This fact can be regarded as a kind of differential misclassification. I assume that the direction of the bias would be toward null. This assumption is supported by the fact that approximately ten percent of the bus company group actually does not have exposures, which is being commercial bus drivers in this study. This leads to fewer hazard exposures in the subject group.

I regarded the control group to contain workers of every industrial sector of Korea in this study. Due to the structure of the Korean Health Insurance System, however, a considerable number of vulnerable workers might be missing in the control group. It is able to include only workers for whom the belonging companies pay the health insurance fee, which is a part of the Four Major Social

Insurances in Korea. These workers inevitably do not include the self-employed, daily laborers and family workers who are not formally paid. The aforementioned kinds of workers are generally not in the official coverage of occupational health services in most countries. The health status of the control group in this study may be inaccurately assessed to be better than the actual status of the ideally comprehensive general worker group. The above statement shows the possibility of exaggerating the relative health risk of the bus company employee group when compared to the control group of this study.

Also, I could only use employees of bus companies in Seoul. As the number of employees in bus companies in Korea is estimated to be >110,000 in 2015, seventeen-thousand employees in Seoul may not sufficiently represent the whole industry [36]. Another differential misclassification which causes the result to be biased toward null exist in this context. General worker group actually contains bus drivers who work for bus companies other than the sixty-five intra-city bus companies of Seoul. Bus drivers in the control group cause unexpected exposures that might lessen the differences between two groups. The effect, however, would not be substantial considering relatively few numbers of bus drivers than general workers. The number of Bus drivers is estimated to be around 1.4% of the control group in the current study. This bias could be reduced if the following studies cover more bus companies of Korea.

Futhermore, There are some inevitable uncertainty of diagnosis. This is because any diagnosis of a disease by any physician in 2014 was considered same in the definition of the diseases in this study.

One can imagine the situation that wrong diagnosis was made for someone within a certain period and were corrected afterward. The patient is generally not considered to have that disease. In the present study, however, he or she may be defined to have the disease. I tried to remove this misclassification by considering the number of diagnoses when defining the diseases, it is not possible to fully remove this false definition. This limitation, however, may not cause considerable bias as this is a non-differential misclassification. The misclassification could have occurred in both groups randomly.

Finally, this is a cross-sectional study. Therefore, causal relationships between occupational risk factors among bus company employees and cardiovascular risks such as hypertension, diabetes, and dyslipidemia could not be inferred. I cannot conclude in the same context that the retirement of the bus company employees with previous cerebrovascular disease caused the discordance of the results among the five diseases. We need longitudinal studies to overcome these limitations and to conclude causal relationships.

Despite these limitations, the present study has a few strong points. First, I could use the data of the whole working population of Korea. Although I inevitably excluded workers without general health check-up data in some analysis, the number of the study participants were enough to represent the actual population. This fact enabled us to directly compare the actual disease prevalence between the two groups. Second, I utilized the propensity score matching technique to compensate the vast difference in base characteristics between bus company employees and general workers. The adjusted logistic regression model and the propensity score matched logistic regression model showed almost the same results. This two-way approache supports the reliability of results. Third, every main diagnosis used in the study was made by physician clinically. Clinical diagnosis comprise not only test results but also a patient's clinical situation and previous medical or surgical history. This may enable more comprehensive definition of the diseases.

This study revealed that more intensive cardiovascular disease prevention measures for bus drivers and other bus company employees should be implemented to reduce the future risk of cardiovascular diseases. Some of the modifiable work-related risk factors, such as long working hours and cabin ergonomics, could be modulated also. Regular cardiovascular risk factor check-up for every bus company employee may be an another effective measure.

To strengthen the evidence of this study's findings, I suggest that further studies with longitudinal design should be conducted. Moreover, in the actual bus driver cohort, the dynamic occupational cohort that consisted of consecutive annual data of the Korean National Health Insurance can be established and analyzed to evaluate the causal relationship [32,37].

Conclusion

I evaluated the cardiovascular disease risks of bus company employees and compared the results to those of the general working population using the Korean National Health Insurance data of year 2014. I found that the odds for having hypertension, diabetes, dyslipidemia and ischemic heart disease were significantly higher in the bus company employee group. To determine the clear causal relationship, further studies with longitudinal design are needed.

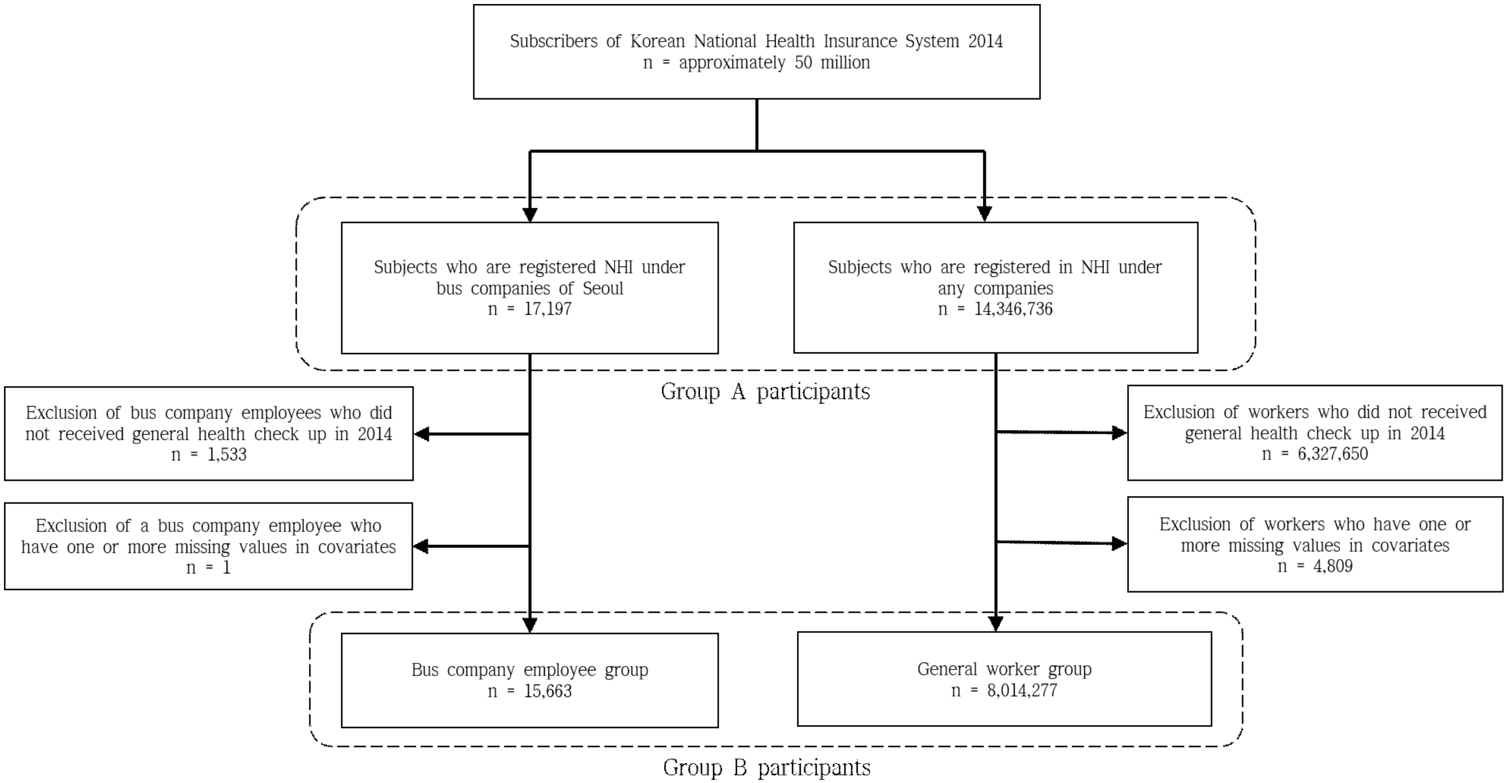

Figure 1. Flow diagram of study participants selection

Table 1. KCD-6 codes used in disease definition

Disease	Diagnosis	KCD-6 Code
Hypertension	primary (essential) hypertension	I10
	hypertensive heart disease	I11
	hypertensive renal disease	I12
	hypertensive heart and renal disease	I13
Diabetes mellitus	non-insulin-dependent diabetes mellitus	E11
Dyslipidemia	disorders of lipoprotein metabolism and other lipidemias	E78
Ischemic heart disease	angina pectoris	I20
	acute myocardial infarction	I21
	subsequent myocardial infarction	I22
	certain current complications following acute myocardial infarction	I23
	other acute ischemic heart diseases	I24
	chronic ischemic heart disease	I25
Cerebrovascular disease	subarachnoid hemorrhage	I60
	intracerebral hemorrhage	I61
	other non-traumatic intracranial hemorrhage	I62
	cerebral infarction	I63
	stroke, not specified as hemorrhage or infarction	I64
	occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction	I65
	occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction	I66
	other cerebrovascular diseases	I67
	cerebrovascular disorders in diseases classified elsewhere	I68
	sequelae of cerebrovascular disease	I69

Table 2. General characteristics of the group A study participants

		Bus company employees		General workers		
		n	%	n	%	p-value
Total		17,197		14,346,736		
Sex	Male	16,383	95.3	8,896,341	62.0	<0.0001
	Female	814	4.7	5,450,395	38.0	
Age	15-29	83	0.5	2,436,142	17.0	<0.0001
	30-39	1,205	7.0	4,189,601	29.2	
	40-49	5,706	33.2	3,979,710	27.7	
	50-59	8,140	47.3	2,740,836	19.1	
	>60	2,063	12.0	983,250	6.9	
Income level	25%P	325	1.9	3,748,760	26.1	<0.0001
	50%P	1,187	6.9	3,512,985	24.5	
	75%P	13,780	80.1	3,526,082	24.6	
	100%P	1,905	11.1	3,541,712	24.7	
General health check-up	Examined	15,664	91.1	8,019,086	55.9	<0.0001
	Not Examined	1,533	8.9	6,327,650	44.1	

Table 3. General characteristics of the group B study participants

		Bus company employees		General workers		
		n	%	n	%	p-value
Total		15,663	100.0	8,014,277	100.0	
Sex	Male	15,046	96.1	5,122,646	63.9	<0.0001
	Female	617	3.9	2,891,631	36.1	
Age	15-29	46	0.3	1,242,061	15.5	<0.0001
	30-39	1,029	6.6	2,335,951	29.1	
	40-49	5,319	34.0	2,221,230	27.7	
	50-59	7,654	48.9	1,659,544	20.7	
	>60	1,615	10.3	555,491	6.9	
Income level	25%P	225	1.4	1,804,538	22.5	<0.0001
	50%P	828	5.3	1,851,116	23.1	
	75%P	12,863	82.1	2,121,340	26.5	
	100%P	1,747	11.2	2,237,283	27.9	
Obesity	yes	6,435	41.1	2,700,380	33.7	<0.0001
	no	9,228	58.9	5,313,897	66.3	
Smoking	yes	3,845	24.5	4,276,687	53.4	<0.0001
	no	11,818	75.5	3,737,590	46.6	
Heavy drinking	yes	2,998	19.1	1,358,965	17.0	<0.0001
	no	12,665	80.9	6,655,312	83.0	
Lack of exercise	yes	5,971	38.1	4,914,918	61.3	<0.0001
	no	9,692	61.9	3,099,359	38.7	

Table 4. General characteristics of bus company employees from the group B and propensity score matched controls

		Bus company employees		Matched Controls(1:3)		
		n	%	n	%	p-value
Total		15,663	100.0	46,989	100.0	
Sex	Male	15,046	96.1	45,204	96.2	0.4297
	Female	617	3.9	1,785	3.8	
Age	15-29	46	0.3	130	0.3	0.9744
	30-39	1,029	6.6	3,097	6.6	
	40-49	5,319	34.0	15,957	34.0	
	50-59	7,654	48.9	22,884	48.7	
	>60	1,615	10.3	4,921	10.5	
Income level	25%P	225	1.4	749	1.6	0.4500
	50%P	828	5.3	2,398	5.1	
	75%P	12,863	82.1	38,591	82.1	
	100%P	1,747	11.2	5,251	11.2	
Obesity	yes	6,435	41.1	19,239	40.9	0.7569
	no	9,228	58.9	27,750	59.1	
Smoking	yes	3,845	24.5	11,515	24.5	0.9146
	no	11,818	75.5	35,474	75.5	
Heavy drinking	yes	2,998	19.1	9,066	19.3	0.6736
	no	12,665	80.9	37,923	80.7	
Lack of exercise	yes	5,971	38.1	17,893	38.1	0.9243
	no	9,692	61.9	29,096	61.9	

Table 5. Cardiovascular disease prevalence of bus company employees and that of general workers from the group A participants

	Bus company employees(n=17,197)		General workers(n=14,346,736)		
	n	%	n	%	p-value
Hypertension	5,169	30.1	1,510,057	10.5	<0.0001
Diabetes	1,839	10.7	539,153	3.8	<0.0001
Dyslipidemia	3,253	18.9	877,210	6.1	<0.0001
Ischemic Heart Disease	594	3.5	182,650	1.3	<0.0001
Cerebrovascular Disease	293	1.7	117,804	0.8	<0.0001

Table 6. Cardiovascular disease prevalence of bus company employees and that of general workers from the group B and matched controls

	Bus company employees (n=15,663)		General workers (n=8,014,277)			Matched Controls (n=46,989)		
	n	%	n	%	p-value	n	%	p-value
Hypertension	5,169	30.1	1,510,057	10.5	<0.0001	1,510,057	10.5	<0.0001
Diabetes	1,839	10.7	539,153	3.8	<0.0001	539,153	3.8	<0.0001
Dyslipidemia	3,253	18.9	877,210	6.1	<0.0001	877,210	6.1	<0.0001
Ischemic Heart Disease	594	3.5	182,650	1.3	<0.0001	182,650	1.3	<0.0001
Cerebrovascular Disease	293	1.7	117,804	0.8	<0.0001	117,804	0.8	0.0363

Table 7. Cardiovascular disease prevalence, defined to be prevalent by the health check-up data in 2014, of bus company employees and that of general workers from the group B

	Bus company employees (n=17,197)		General workers (n=14,346,736)		
	n	%	n	%	p-value
Hypertension	5,169	30.1	1,510,057	10.5	<0.0001
Diabetes	1,839	10.7	539,153	3.8	<0.0001
Dyslipidemia	3,253	18.9	877,210	6.1	<0.0001

Table 8. Odds ratios for cardiovascular diseases of bus company employees compared to those of general workers from the group A

	Odds ratio (95%CI)	
	Crude model	Adjusted model*
Hypertension	3.65 (3.53–3.77)	1.81 (1.75–1.88)
Diabetes	3.06 (2.92–3.22)	1.51 (1.43–1.58)
Dyslipidemia	3.68 (3.44–3.72)	1.99 (1.91–2.07)
Ischemic Heart Disease	2.77 (2.55–3.01)	1.21 (1.12–1.32)
Cerebrovascular Disease	2.01 (1.87–2.35)	1.04 (0.92–1.17)

*Adjusted for age groups and sex.

Table 9. Odds ratios for cardiovascular diseases of bus company employees compared to those of general workers from the Group B participants

	Odds ratio (95%CI)		
	Crude model	Adjusted model 1*	Adjusted model 2**
Hypertension	3.65 (3.53-3.77)	1.81 (1.75-1.88)	1.79 (1.72-1.85)
Diabetes	3.06 (2.92-3.22)	1.51 (1.43-1.58)	1.57 (1.49-1.65)
Dyslipidemia	3.68 (3.44-3.72)	1.99 (1.91-2.07)	1.96 (1.88-2.04)
Ischemic Heart Disease	2.77 (2.55-3.01)	1.21 (1.12-1.32)	1.30 (1.19-1.42)
Cerebrovascular Disease	2.01 (1.87-2.35)	1.04 (0.92-1.17)	1.09 (0.96-1.23)

* Adjusted for age groups and sex.

**Adjusted for age groups, sex, income level quartiles, lack of exercise, smoking status, heavy drinking and obesity.

Table 10. Odds ratios for cardiovascular diseases of bus company empolyees from the group B participants compared to those of the propensity score matched controls

	Odds ratio (95%CI)
	Propensity Score Matched
Hypertension	1.58 (1.51–1.64)
Diabetes	1.49 (1.40–1.59)
Dyslipidemia	1.91 (1.82–2.01)
Ischemic Heart Disease	1.31 (1.18–1.45)
Cerebrovascular Disease	1.17 (1.01–1.35)

Table 11. Odds ratios for cardiovascular diseases, defined by general health check-up data in 2014, of bus company employees compared to those of general workers from the group B participants

	Odds ratio (95%CI)		
	Crude model	Adjusted model 1*	Adjusted model 2**
Hypertension	2.12 (2.05-2.19)	1.07 (1.03-1.11)	1.11 (1.08-1.16)
Diabetes	1.98 (1.89-2.08)	1.03 (0.98-1.08)	1.04 (1.00-1.10)$^{-}$
Dyslipidemia	1.65 (1.60-1.71)	1.01 (0.98-1.05)	1.03 (1.00-1.07)$^{+}$

* Adjusted for age groups and sex.

**Adjusted for age groups, sex, income level quartiles, lack of exercise, smoking status, heavy drinking and obesity.

\- Statistically insignificant

\+ Statistically significant

Table 12. The odds ratios for cardiovascular diseases of bus company employees compared to those of general workers from the group B participants according to the definition of the diseases

	Odds ratio (95%CI)*		
	Diagnosed same or more than 1 time	Diagnosed same or more than 2 times**	Diagnosed same or more than 3 times
Hypertension	1.59 (1.54-1.65)	1.79 (1.72-1.85)	1.82 (1.75-1.89)
Diabetes	1.32 (1.25-1.39)	1.57 (1.49-1.65)	1.47 (1.93-1.55)
Dyslipidemia	1.30 (1.25-1.36)	1.96 (1.88-2.04)	1.83 (1.75-1.92)
Ischemic Heart Disease	1.03 (0.94-1.12)	1.30 (1.19-1.42)	1.32 (1.20-1.46)
Cerebrovascular Disease	0.81 (0.72-0.92)	1.09 (0.96-1.23)	1.11 (0.97-1.28)

* Adjusted for sex, income level quartiles, lack of exercise, smoking status, heavy drinking and obesity.

**Used as the definition of the diseases in the study.

Table 12 Continued.

	Odds ratio (95%CI)*	
	Diagnosed same or more than 6 times	Diagnosed same or more than 12 times
Hypertension	2.62 (2.52-2.72)	6.60 (6.33-6.87)
Diabetes	1.86 (1.76-1.97)	4.01 (3.76-4.28)
Dyslipidemia	3.06 (2.91-3.22)	8.11 (7.60-8.64)
Ischemic Heart Disease	2.75 (2.47-3.06)	7.38 (6.32-8.61)
Cerebrovascular Disease	2.06 (1.77-2.40)	4.49 (3.58-5.64)

* Adjusted for sex, income level quartiles, lack of exercise, smoking status, heavy drinking and obesity.

Table 13. Odds ratios for cardiovascular diseases of male bus company employee compared to those of male general workers from the group B participants

	Odds ratio (95%CI)*
Hypertension	1.79 (1.72-1.86)
Diabetes	1.56 (1.48-1.64)
Dyslipidemia	2.01 (1.92-2.09)
Ischemic Heart Disease	1.29 (1.18-1.41)
Cerebrovascular Disease	1.10 (0.97-1.25)

*Adjusted for age groups, income level quartiles, lack of exercise, smoking status, heavy drinking and obesity.

Table 14. Odds ratios for cardiovascular diseases of bus company employee aged between 40 and 59 compared to those of general workers in the same age range from the group B participants

	Odds ratio (95%CI)*
Hypertension	1.99 (1.91-2.07)
Diabetes	1.72 (1.63-1.82)
Dyslipidemia	2.13 (2.04-2.23)
Ischemic Heart Disease	1.62 (1.47-1.78)
Cerebrovascular Disease	1.34 (1.17-1.55)

*Adjusted for sex, income level quartiles, lack of exercise, smoking status, heavy drinking and obesity.

Table 15. Odds ratios for cardiovascular diseases of bus company employee in the third income level quartile compared to those of male general workers in the same income level quartile from the group B participants

	Odds ratio (95%CI)*
Hypertension	1.72 (1.65-1.79)
Diabetes	1.60 (1.51-1.69)
Dyslipidemia	2.05 (1.96-2.15)
Ischemic Heart Disease	1.43 (1.30-1.58)
Cerebrovascular Disease	1.26 (1.10-1.45)

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국문초록

국민건강보험 청구 자료에 따른 버스 회사 직원과 일반 노동자 간 심혈관 질환 위험도의 차이

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버스 운전기사를 비롯한 직업운전기사들은 다른 직업군에 비해 심혈관계 질환의 위험성이 높은 것으로 알려져 있다. 국내에서도 수백 명의 버스 기사들을 대상으로 한 연구에서 심혈관계 질환 위험도가 높은 결과를 보고한 바 있다. 본 연구에서 저자는 2014년도 국민건강보험 청구 자료를 이용해 버스회사 직원들의 심혈관계 질환의 위험도를 산출하고 일반 노동자군과 비교하였다. 직군정보가 아닌 회사정보가 기록되는 국민건강보험 자료 특성에 따라 버스 운전기사의 대리지표로 버스회사직원을 사용하였다.

국민건강보험 청구 자료상의 한국표준질병·사인분류 6차 개정 진단명에 따라 고혈압, 당뇨, 이상지질혈증, 허혈성 심장 질환, 뇌혈관질환을 정의하였다. 오분류를 줄이기 위해 2014년도 일년 내에 두 차례 이상 상기

기준에 맞는 진단명으로 청구 자료가 있는 대상자를 유질환자로 정의하였다. 연구 분석 대상자는 전체 직장인 자료를 활용한 군과 2014년도 당해 일반건강검진을 수검한 군 두 가지로 설정하였다.

버스회사 직원과 일반 노동자 사이에서의 상기 다섯 가지 질환의 유병률을 산출하여 비교하였다. 단변수 분석 및 공변량을 보정한 다중 로직스틱 분서을 활용하여 두 군 간의 질환 유병에 대한 오즈비를 산출하였다. 버스회사 직원과 일반 노동자 간의 인구학적 특성이 크게 다른 점을 보완하기 위해 성향점수를 활용하여 1:3으로 짝짓기 하여 분석을 되풀이하였다.

버스회사 직원 군의 다섯가지 질환 유병률은 일반 노동자 군에 비해 높았다. 버스회사 직원은 일반 노동자나 성향점수로 짝짓기 된 대조군과 비교하여 고혈압, 당뇨, 이상지질혈증 및 허혈성 심장질환을 앓고 있을 오즈가 높게 나타났다. 뇌혈관질환의 오즈비는 분석 방법에 따라 일관되지 않은 결과를 보였다.

본 연구는 버스 운전기사들을 대상으로 한 뇌심혈관계 질환 예방 대책 시행에 대한 과학적인 증거를 제시하였다. 본 연구 결과가 제시하는 연관성을 공고히 하며 인과 관계를 확인하기 위해 추후에 종적으로 설계된 연구를 시행하여야 한다.

주요어: 버스회사 직원, 직업운전기사, 일반 노동자, 심혈관계 질환, 국민건강보험 청구자료
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