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Differences in Prevalence of Diabetes by Occupational Groups and Contributing Factors to Diabetes: Korea National Health and Nutrition Examination Survey 2016-2018

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Abstract

Differences in Prevalence of Diabetes by Occupational Groups and Contributing Factors to Diabetes: Korea National Health and Nutrition Examination Survey 2016-2018

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Introduction: Diabetes is a steadily increasing public health problem worldwide. Likewise in Korea, diabetes has been on the rise over the past few years, which is a chronic disease that should be dealt with importantly. There have been many studies that have identified risk factors for diabetes. However, relatively few studies have discussed relevance between diabetes and occupation. As the industry develops and the industrial structure changes, the occupation is undergoing

many changes. If this change is related to the trend of diabetes, the relationship should be found and fully responded to. Therefore, the purpose of this study is to identify occupational groups that are vulnerable to diabetes and to discover contributing factors to diabetes depending on occupational groups.

Methods: Korea National Health and Nutrition Examination Survey, an investigation prescribed by law into the health behaviors of the people, the prevalence of chronic diseases, and the status of food and nutrition intake, was used to analyze the data for the last three years from 2016 to 2018. The participants are 16,380 adults over 19 years old who participated in the examination and survey. It consists of 7,189 men and 9,191 women. The ages were divided into 20s-30s, 40s, 50s, 60s and over 70s. The occupation is classified with Korean Standard Classification of Occupations which is based on International Standard Classification of Occupations of the International Labor Organization, which was reclassified into manual workers, non-manual workers, service and sales workers and unemployed workers based on occupational characteristics. Diabetes criteria are defined as fasting blood sugar of more than 126 mg/dL, a doctor's diagnosis, taking medicine that lowers blood sugar, or getting an insulin injection. To identify the difference among occupations in the prevalence of diabetes, chi-square test analysis was performed, and multiple variables were adjusted to determine odds ratio changes of the prevalence of diabetes in occupations and then multiple logistic regression was performed. The results presented a 95% confidence intervals(CIs) and odds ratios(ORs). Also, relative contribution of confounding and various effect modifications were analyzed. The statistical analysis used R ver. 4.0.3.

Results: In men, the prevalence of diabetes by occupations is manual workers (odds ratio[OR] 1.00, 95% confidence interval[CI] ref); non-manual workers (OR 1.02, 95% CI 0.81-1.27); service and sales workers (OR 1.03, 95% CI 0.79-1.35); unemployed workers (OR 0.86,

95% CI 0.72-1.02). On the other hand, in women, manual workers (OR 1.00, 95% CI ref), non-manual workers (OR 1.09, 95% CI 0.77-1.55), service and sales workers (OR 1.29, 95% CI 1.00-1.67), unemployed workers (OR 1.35, 95% CI 1.11-1.63). As a result, no statistically significant occupations were found in men. However, service and sales(P-value, 0.0473) and unemployed workers (P-value, 0.0023) were statistically significant in women. In addition, for both men and women in service and sales, age and education levels contributed relatively to the high risk of diabetes. For all occupations, age, income and physical activity contributed to diabetes in men, and age, income and BMI contributed to diabetes in women.

Conclusion: This study analyzed differences in the risk of diabetes by occupational group, and found that risk of diabetes is high in service and sales in women. In addition, age and education level contributed significantly to risk of diabetes. Also, income levels in all occupations contribute to diabetes risk. Based on the results of this study, we propose to manage and prevent the health of women in service and sales. Moreover, improvements in the workplace are suggested for low socioeconomic and diabetic workers.

keywords : Diabetes, Occupation, Prevalence, Effect modification

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Chapter 1. Introduction

1.1 Background

"Halt the rise in diabetes and obesity" is a global action plan of the World Health Organization (WHO) and diabetes is a serious problem all over the world. Also, the prevalence of diabetes is steadily increasing. Diabetes has soared by 70% over the past 20 years, ranking ninth among the world's top 10 causes of death. With the current trend, the number of people with diabetes worldwide is expected to reach 700 million (10.9%) in 2045, up 51% from 2019 [1].

The prevalence of diabetes in Korea has not changed much since 2005, with one in 10 people suffering from diabetes [2]. According to the Korean Diabetes Association(KDA), the population including diabetes and fasting blood sugar disorders amounts to 14.4 million [3].

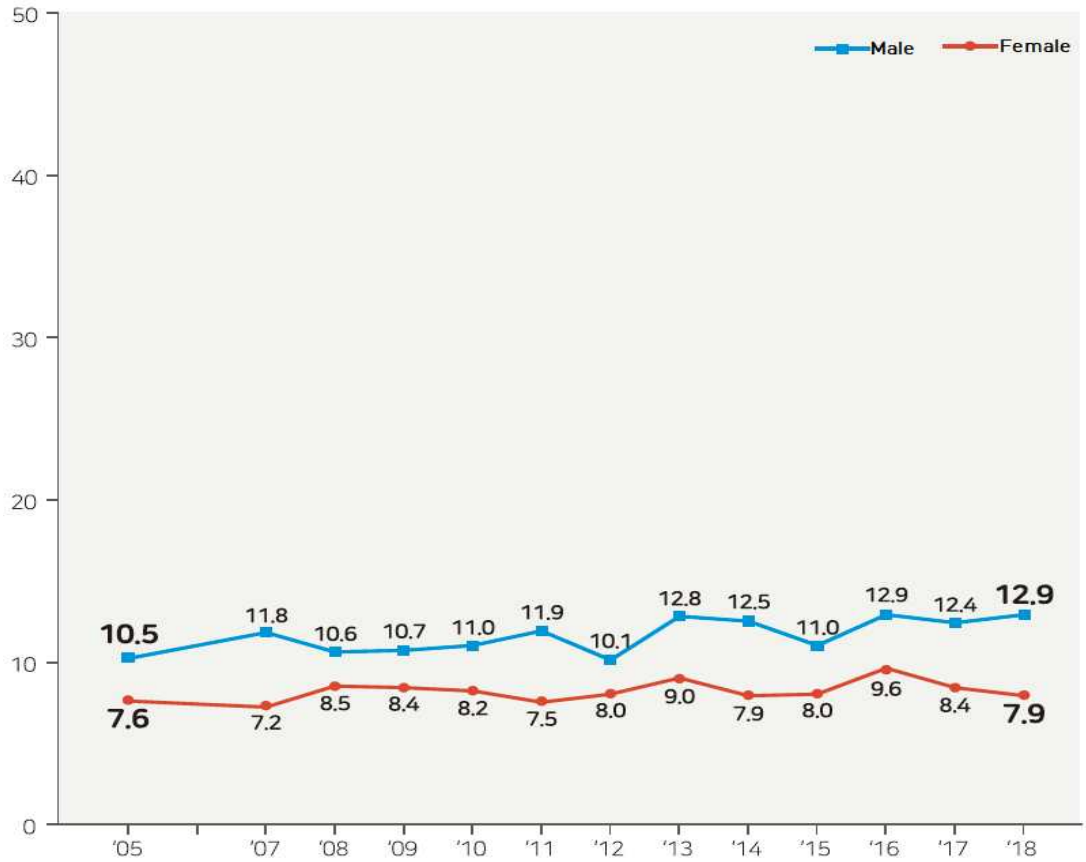


Figure 1. Trends in the prevalence of diabetes by gender

The prevalence of diabetes is rapidly increasing around the world, and the socioeconomic burden is also increasing as Korea is also showing an increasing trend (Figure 1[2]). Diabetes all over the world was responsible for an estimated $760 billion in health expenditure in 2019 [4]. The diabetes-related economic burden in Korea was USD 18,293 million, with an average per capita cost of USD 4090 in 2019 [5]. In view of this socioeconomic burden, diabetes needs to be treated importantly when it comes to health policy.

Various studies have been conducted to treat this growing diabetes, including diet and exercise as well as drug therapy [6]. In

addition, many studies have been conducted on diabetes risk based on sociodemographic factors, socioeconomic status (SES), or behavioral factors, and recent studies have reported differences in the prevalence of diabetes by occupation [7,8]. Many prior studies have found the cause of increased prevalence of diabetes. But relatively little research has been done to determine association between diabetes and occupation. Recent changes in industry and industrial structure affect employment and working conditions, which means that occupational effects on diabetes risk are constantly changing as well. In addition, demographic features, socioeconomic features, behavior, and lifestyle patterns vary by occupation. Hence, depending on the characteristics of the occupational groups, the contributing factors and individual effects to the cause of the disease may be various, and the risk for certain diseases may be higher by the occupational groups. According to a study [9], occupation and work patterns are associated with controlling diabetes and causing diabetes with metabolic syndrome.

The occupation is undergoing many changes, and if this change is related to the trend of diabetes, the relationship should be found and fully responded to. Therefore, it is necessary to explore public health issues by discovering risk groups for diabetes in occupation and identifying contributing factors for each occupational group.

1.2 Literature Review

Diabetes is steadily increasing around the world, and many studies have been conducted on the factors contributing to diabetes. Demographic changes such as population growth, aging and urbanization have contributed even more to the increase in the prevalence of diabetes [10], which has also changed lifestyles. Contributors to diabetes have been known to date include sociodemographic factors, socioeconomic factors and behavioral factors (Figure 2[11,12,13,14,15,16]).

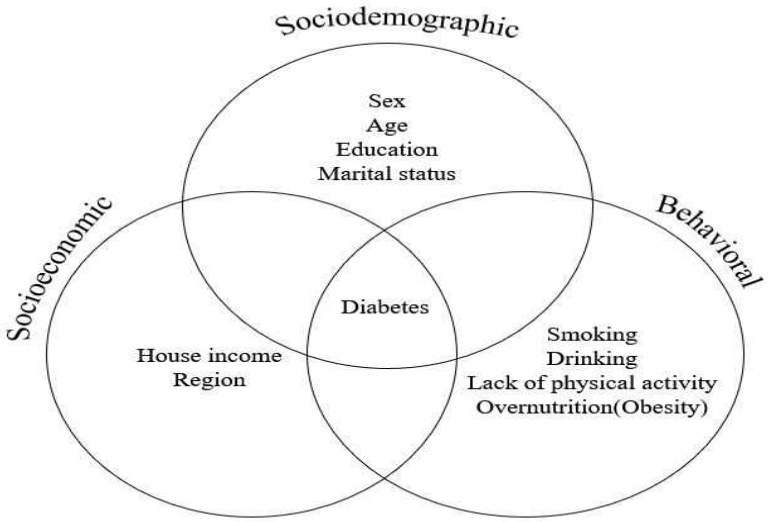


Figure 2. Contributing factors to diabetes

The risk of diabetes depends on the socioeconomic status (SES), which is higher in people with lower SES in income, education or occupation [17]. In a study in Sweden, people with low SES and unemployed workers are occupational groups with major

differences in diabetes [18], which can be linked to behavioral factors known to cause diabetes. That is, these health determinants also differ in the prevalence of diabetes by occupation. In the study [18], the prevalence of 30 most common occupations in Sweden was highest in motor vehicle drivers and manufacturing labourers in order, and lowest in computer scientists, college and university teachers in order. For women, it was the highest in manufacturing labourers and kitchen assistants in order, and the lowest in specialist managers and writers, creative or performing artists in order. Both men and women had a high prevalence of diabetes in low income and high manual labor. In contrast, a low prevalence was shown in professional workers or office workers with high income.

According to another study[19] that calculated the prevalence of diabetes in occupation by being divided into nine occupational groups using the Korean Standard classification of occupation, the prevalence rate was the highest in managers; the lowest in elementary workers. The risk of diabetes was higher in service and sales workers, managers, clerks, craft and related trades workers than in elementary workers. Also, when classified by the degree of manual labor, the risk of diabetes in non-manual workers was higher than in manual workers. The other study [8] that categorizes occupations by the same criteria found that the highest prevalence of diabetes was unemployed workers; the lowest prevalence of diabetes was professional and administrator in men. Meanwhile, the highest prevalence was unemployed workers in women; the lowest prevalence of diabetes was office workers. In men, the risk of diabetes was highest in service and sales workers and agriculture, forestry and fishery workers, while it had no significant results in women [8]. These two studies [8,19] have somewhat different results depending

on the timing of the analysis, the study population, and the method of analysis that does not divide gender.

For the study [19] mentioned above, the study population was sufficient, but the composition ratio by gender is significantly different and the number of women is significantly smaller. So the study was not conducted separately by gender. However, according to the data from the Korea National Health and Nutrition Examination Survey, the prevalence of diabetes between men and women in Korea is different considerably, and the distribution of women and men is different depending on the occupation. Therefore, it needs to be analyzed separately by gender. In the study [8] mentioned above, the study population was not large. Also, BMI and physical activity, which are known to be highly related to diabetes, were not adjusted. Therefore, this study seeks to supplement such weaknesses in previous studies, discovering the differences in the prevalence of diabetes by occupation. Also, previous studies have only analyzed the prevalence and the risk of diabetes with odds ratios(ORs), and have not identified contributing factors. Hence, it is necessary to additionally identify them through this study.

1.3 Objectives

The study starts with the hypothesis that diabetes has different effects on each occupational group. In other words, the risk of diabetes in particular occupational groups is likely to appear different as occupational groups are changing. Therefore, the objectives of this study are as follows: Firstly, this study finds the differences in the prevalence of diabetes by occupational groups and explores the occupation that is vulnerable to diabetes. Secondly, it checks the relative confounding effect in the specific occupational group that is vulnerable to diabetes that we have identified in the first objective. Finally, it identifies contributing factors to diabetes by occupational groups through effect modification.

Chapter 2. Methods

2.1 Data source and Study population

The Korea National Health and Nutrition Examination Survey is an investigation prescribed by law into the health behaviors of the people, the prevalence of chronic diseases, food and nutrition conditions conducted based on Article 16 of the National Health Promotion Act. This study selected 192 sample survey districts and 4,416 households respectively from 2016 to 2018 [20]. This study analyzed the recent three-year data conducted from 2016 to 2018 to identify occupation vulnerable to diabetes and analyze contributing factors. The subjects are 16,380 adults over 19 years old who participated in the examination and survey. It consists of 7,189 men and 9,191 women. The ages were divided into 20s and 30s, 40s, 50s, 60s and over 70s.

Participants were selected according to the following exclusion criteria: 1) subjects under 19 years old; 2) missing data within diabetes; 3) missing data within occupation; 4) missing data within BMI and others(covariates). That is to say, of the 24,269 participants in the baseline, subjects under 19 years old(N=4,880) were excluded. Missing information about diabetes (N=2,057) and occupation(N=780) respectively were excluded. And then, missing information(or “Unknown”) about covariates, such as BMI, smoking, drinking, physical activities, education level, income etc (N=172), were excluded. After this selection process, 16,380 participants (7,189 men and 9,191

women) were included in the analysis (Figure 3).

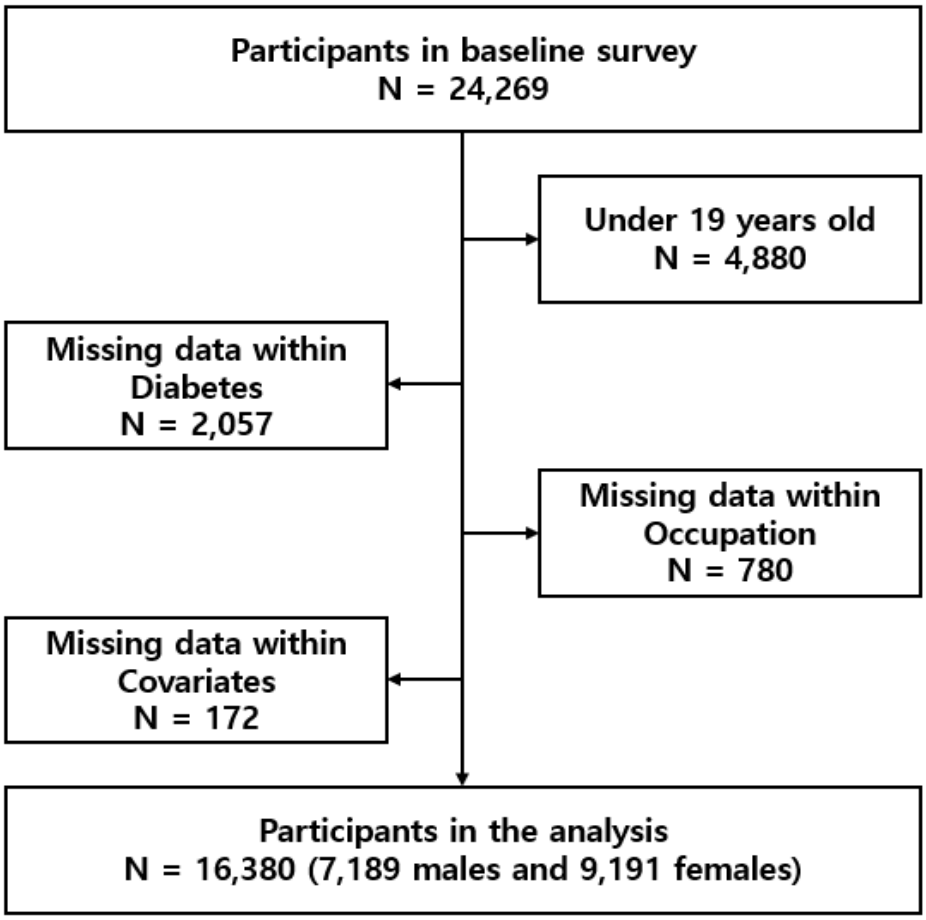


Figure 3. Flow chart of the study sample

The study was approved by the Institutional Review Board (IRB) of Seoul National University (IRB No. E2104/002-004).

2.2 Measurement

2.2.1 Classification of Occupations

The occupation is classified with Korean Standard Classification of Occupations [21] which is based on International Standard Classification of Occupations of the International Labor Organization and the Korea National Health and Nutrition Examination Survey follows the same classification system. It is shown in Table 1.

Table 1. Korean Standard Classification of Occupations

Occupation	Explanation
A. Managers, Professional and related workers	A manager is group of occupations that analyzes, evaluates, determines, directs, and coordinates the duties of others.
	Professional and related workers are occupations related to the analysis of managers and data, and are responsible for researching, developing and improving the relevant field by applying scientific concepts and theories based on high-level professional knowledge and experience in the fields of physics, life sciences and social sciences.
B. Clerks	Clerks is group of the occupation assisting managers, experts, and related workers, formulating business plans with management policies, implementing jobs with plans, and performing duties such as recording, storing, calculating, and retrieving data related to the relevant work.
C. Service workers, Sales workers	A service worker is a group of professionals who mainly provide public and private services related to public safety or personal protection, medical assistance, dental, beauty, wedding and funeral, transportation, leisure, and cooking.
	Sales workers are those who sell goods or services through sales activities, use communications such as the Internet, or sell or lease products in stores, streets and public places.
D. Agricultural,	In accordance with his/her plan and judgment based on necessary knowledge and experience for agricultural, forest, and fishery products, they grow and

Forestry and Fishery workers	harvest crops as well as they breed animals. Also, they cultivate, preserve and develop forests as well as they reproduces fish and other aquatic plants.
E. Equipment, Machine operation and Assembling workers	Equipment and related workers mold metals, install and repair various machinery by applying knowledge and technology related to the mining, manufacturing, and construction industries. They are also responsible for processing textiles, handicrafts and wood, metals and other products.
	Machine operation and Assembling workers manipulate machines to produce products and manipulate large and sometimes highly automated industrial machinery and equipment. Also, they assemble products with parts. Work requires experience and understanding of machines and equipment, including the ability to adapt to technical innovations such as machine control by computers, and their performance determines productivity. This also includes the operation of transport equipment.
F. Elementary workers	It mainly involves the use of simple hand tools and tasks that are simple and routine, requires considerable physical effort in some cases, and requires almost limited creativity and judgment.
G. Unemployed (housewife, student)	It includes housewives and students who do not have a job except for soldiers.

Seven occupations classified like Table 1 were reclassified into manual workers, non-manual workers, service and sales workers and unemployed workers depending on occupational characteristics. Manual workers consist of agricultural, forestry and fishery workers(D), equipment, machine operation and assembling workers(E) and elementary workers(F). Non-manual workers consist of managers, professional and related workers(A) and clerks(B). And there are service workers and sales workers(C) and unemployed workers(G) respectively. Therefore, this study analyzed the four occupational groups classified as above.

2.2.2 Outcome

The outcome variable of this study is diabetes. The diagnostic criteria for diabetes were used by International Expert Committee in the American Diabetes Association (ADA). In other words, diabetes was defined as fasting blood sugar of more than 126 mg/dL, a doctor's diagnosis, taking medicine that lowers blood sugar, or getting an insulin injection.

2.2.3 Other variables (Covariates)

The age was classified as 20-30s, 40s, 50s, 60s, over 70s. According to the Asia-Pacific BMI criteria, BMI was classified as underweight(<18.5 kg/㎡), normal (18.5 kg/㎡≤ BMI <25.0kg/㎡) and obese (25.0 kg/㎡≤). Smoking status was divided into smoking and non-smoking in the past and smoking in the present. Drinking was classified into non-drinking for the whole life, less than one drink per month over the past year, and more than one drink per month over the past year. Aerobic physical activity was classified as whether medium-intensity physical activity is practiced for at least two and a half hours a week, high-intensity physical activity for at least one hour and 15 minutes, or each activity that medium-intensity and high-intensity physical activity is mixed is conducted. Education level was classified as graduation from elementary or middle school, graduation from high school and graduating from University or higher. The average monthly household income was classified as less

than 2.5 million won, more than 2.5 million won to less than 5 million won and more than 5 million won to 15 million won.

2.3 Statistical analysis

Differences in general characteristics of each occupation of study participants were identified through Chi-square tests. After dividing the groups of study participants by gender, differences in general characteristics and prevalence of diabetes by occupation and age group were confirmed through Chi-square tests. Multiple logistic regression was performed after adjusting occupation, age, BMI, education level, monthly average household income, drinking, smoking status, and aerobic physical activity to determine the odds ratios(ORs) of the prevalence of diabetes by gender and then odds ratios(ORs) and 95% confidence intervals(CIs) were presented. Also, some variables, such as age, BMI, education level, monthly average household income, drinking, smoking status, and aerobic physical activity, were selected to identify odds ratio changes(%) in an occupational group. Moreover, to find out the effect modifications of occupational groups on the risks of diabetes by gender, statistically significant interaction terms were selected and effect modification graphs were presented. This statistical analysis used R ver. 4.0.3. For logistic regression, the 'glm' function was used. Relative contribution of confounding variables was explored by the 'chest' package. Also, various effect modifications among variables were explored by 'interactions' package.

Chapter 3. Results

3.1 Descriptive analysis of the study participants

Table 2. Baseline characteristics of the study subjects by occupation

Characteristic	Manual workers (n=3,781)	Non-manual workers (n=4,185)	Service/Sales workers (n=2,132)	Housewife, Unemployed (n=6,282)	Total (n=16,380)	P value
Age						<0.001
19-39	14.8	44.7	29.0	24.8	28.1	
40-49	17.0	30.5	22.0	11.2	18.9	
50-59	26.6	17.7	29.6	12.5	18.8	
60-69	26.7	5.8	14.9	21.0	19.3	
70 ≤	14.9	1.3	4.5	30.6	17.6	
Sex						<0.001
Men	62.7	51.2	34.0	31.0	43.9	
Women	37.3	48.8	66.0	69.0	56.1	
Body Mass Index(kg/m^2)						<0.001
Underweight	2.2	4.3	3.4	4.2	3.7	
Normal	58.6	63.5	60.7	62.1	61.5	
Obese	39.2	32.2	35.9	33.7	34.8	
Smoking						<0.001
Never	74.1	80.6	78.7	88.7	82.0	
Smoking	25.9	19.4	21.3	11.3	18.0	
Drinking						<0.001

Never drink/low risk	41.5	33.7	38.5	57.6	45.3	
Drinker	58.5	66.3	61.5	42.4	54.7	
Vigorous physical activity						<0.001
None	59.9	50.8	56.1	58.3	56.4	
Do	40.1	49.2	43.9	41.7	43.6	
Educational level						<0.001
Elementary/Middle school	46.2	1.4	24.6	40.6	29.8	
High school	37.7	21.0	48.7	31.1	32.3	
University ≤	16.1	77.6	26.7	28.4	37.9	
Income						<0.001
< 250 (Low)	38.4	10.4	26.7	45.7	32.5	
250-500 (Middle)	36.5	30.3	36.5	27.5	31.5	
500-1500 (High)	25.1	59.3	36.7	26.8	36.0	
Suicide						<0.001
Yes	1.6	0.9	1.1	2.2	1.6	
No	32.3	33.9	28.4	30.7	31.6	
N/A	66.1	65.2	70.5	67.1	66.8	
Depression						<0.001
Yes	4.0	2.7	3.5	4.9	3.9	
No	29.9	32.1	26.0	28.0	29.2	
N/A	66.1	65.2	70.5	67.1	66.9	
Stress						<0.001
Yes	23.2	32.4	29.3	23.9	26.6	
No	76.8	67.6	70.7	76.1	73.4	

* Value is presented as a percent(%). To compare the differences among four occupational groups, P-value is calculated through a Chi-square test of categorical variables.

* Suicide: suicidal thoughts for the last year
* Depression: more than two consecutive weeks
* Stress: stress recognition rate in everyday life

The general characteristics of subjects surveyed by occupation are shown in Table 2. When compared by age in each occupation, non-manual workers are the highest at 20s-30s(44.7%) and 40s(30.5%) respectively. Service and sales workers are the highest at 50s(29.6%) and manual workers are the highest at 60s(26.7%). Also, unemployed workers are the highest at 70s(30.6%). When compared by gender in each occupation, manual workers in men are the highest at 62.7%, and unemployed workers are the lowest at 31.0%. For women, unemployed workers are the highest at 69.0% and manual workers are the lowest at 37.3%. When compared by Body Mass Index (BMI), obese in the manual workers is the highest at 39.2%, and obese in non-manual workers are the lowest at 32.2%.

In terms of smoking in each occupation, the number of manual workers is the highest at 25.9%, while the number of unemployed workers is the lowest at 11.3%. In drinking, non-manual workers are the highest at 66.3%, while unemployed workers are the lowest at 42.4%. In general, all occupations do not perform aerobic physical activity at a similar rate, but non-manual occupations do aerobic physical activity at 49.2%.

At the education level in each occupation, manual workers are the highest at 46.2% of elementary or middle school graduates, and non-manual workers are the lowest at 1.4%. Service and sales workers are the highest at 48.7% of high school graduates, while non-manual workers are the lowest at 21.0%. Non-manual workers are the highest at 77.6% of university graduates, while manual

workers are the lowest at 16.1%. In the case of monthly average household income except for unemployed workers, manual workers are the lowest at 38.4% in low income and manual workers and service and sales workers are the highest at 36.5% respectively in middle income. Non-manual workers are the highest at 59.3% in high income, while non-manual workers are the lowest at 25.1%.

In terms of suicidal thoughts for a year, unemployed workers are the highest at 2.2%, while non-manual workers are the lowest at 0.9%. At the depression for more than two consecutive weeks, unemployed workers are the highest at 4.9% and non-manual workers are the lowest at 2.7%. At the stress, non-manual workers are the highest at 32.4% and manual workers are the lowest at 23.2%.

Table 3. Baseline characteristics of the study subjects by gender

Variables	Characteristic		
	Men	Women	P-value
Age			<0.001
19-39	29.1	27.4	
40-49	18.4	19.2	
50-59	18.5	19.9	
60-69	17.8	17.5	
70 ≤	16.2	16.0	
Body Mass Index(kg/m^2)			<0.001
Underweight	2.4	4.7	
Normal	56.7	65.2	
Obese	40.9	30.1	
Educational level			<0.001

Elementary/Middle school	23.9	34.4	
High school	34.3	30.8	
University ≤	41.8	34.8	
Income			<0.001
< 250 (Low)	30.6	34.1	
250-500 (Middle)	32.4	30.7	
500-1500 (High)	37.0	35.2	
Drinking			<0.001
Never drink/low risk	29.1	57.9	
Drinker	70.9	42.1	
Smoking			<0.001
Never	65.3	95.0	
Smoking	34.7	5.0	
Vigorous physical activity			<0.001
None	53.3	58.9	
Do	46.7	41.1	
Suicide			0.089
Yes	1.4	1.7	
No	32.3	31.1	
N/A	66.3	67.2	
Depression			<0.001
Yes	3.1	4.6	
No	30.6	28.2	
N/A	66.3	67.2	
Stress			<0.001
Yes	24.2	28.4	

No	75.8	71.6

* Value is presented as a percent(%). To compare the differences among four occupational groups, P-value is calculated through a Chi-square test of categorical variables.

The general characteristics of participants divided by gender are shown in Table 3. A total of 7,189 men consist of 29.1% in the 20s-30s, 18.4% in the 40s, 18.5% in the 50s, 17.8% in the 60s, and 16.2% in the 70s and order by age. Also, BMI consists of 2.4% underweight, 56.7% normal weight and 40.9% overweight.

A total of 9,191 women are composed of 27.4% in the 20s -30s, 19.2% in the 40s, 19.9% in the 50s, 17.5% in the 60s and 16.0% in the 70s and order by age. Also, BMI consists of 4.7%, underweight, 65.2% normal weight and 30.1% overweight.

For education level, the percentage of women graduating from middle school or below is 34.4%, men graduating from high school are 34.3% and men graduating from university graduates or higher are 41.8%. In the case of average monthly average house income, low income of women is 34.1%, middle income of men is 32.4% and high income of men is 37.0%. During the last year, the rate of drinking more than once a month for men is 70.9%, which is higher than for women at 42.1%. At smoking status, it is accounted for 34.7% for men, which is higher than for women at 5.0%. Aerobic physical activity is composed of 46.7% for men, which is higher than for women at 41.1%. In stress, the subjects who answered "Yes" in women account for 28.4%, which is higher than men.

3.2 Prevalence of Obesity and Diabetes

Table 4. Comparison of the prevalence of obesity by age and occupation

Variables	Men								Women								p value
	Total		Under weight		Normal		Obese		Total		Under weight		Normal		Obese		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
	7,189	100.0	170	2.0	4,073	57.0	2,946	41.0	9,191	100.0	432	5.0	5,995	65.0	2,764	30.0	
Age																	<0.05
19-39	2,090	29.2	61	2.9	1,130	54.1	899	43.0	2,515	27.4	258	10.3	1,770	70.3	487	19.4	
40-49	1,326	18.4	23	1.7	669	50.5	634	47.8	1,767	19.2	72	4.1	1,237	70.0	458	25.9	
50-59	1,333	18.5	22	1.7	744	55.8	567	42.5	1,829	19.9	48	2.6	1,214	66.4	567	31.0	
60-69	1,279	17.8	20	1.6	764	59.7	495	38.7	1,607	17.5	23	1.4	950	59.1	634	39.5	
70 ≤	1,161	16.1	44	3.8	766	66.0	351	30.2	1,473	16.0	31	2.1	824	55.9	618	42.0	
Occupation																	<0.05
Manual workers	2,372	33.0	53	2.2	1,352	57.0	967	40.8	1,409	15.3	30	2.1	865	61.4	514	36.5	
Non-manual workers	2,143	29.8	24	1.1	1,136	53.0	983	45.9	2,042	22.3	156	7.6	1,522	74.6	364	17.8	
Service/ Sales workers	724	10.1	22	3.0	383	52.9	319	44.1	1,408	15.3	51	3.6	912	64.8	455	31.6	
Housewife, Unemployed	1,950	27.1	71	3.6	1,202	61.7	677	34.7	4,332	47.1	195	4.5	2,696	62.2	1,441	33.3	

* Data are presented as number, P value < 0.05 by chi-square test.

The ratio of underweight, normal and obesity measured by age and occupation by gender is shown in Table 4. In underweight, it is accounted for 2.0% in men and for 5.0% in women. In normal weight, it is accounted for 57.0% in men and for 65.0% in women

and in obesity, it is accounted for 41.0% in men and for 30.0% in women(Table 4).

In obesity, both men and women in the 20s-30s account for 43.0% and 19.4%, respectively. After the 50s, obesity in men decreases as age increases but obesity in women increases. In obesity, non-manual workers in men(45.9%) are the highest and unemployed workers(34.7%) are the lowest by occupation. Manual workers in men account for 40.8% and service and sales workers account for 44.1%. Meanwhile, in obesity, manual workers in women(36.5%) are the highest and non-manual workers(17.8%) are the lowest. Service and sales workers in women account for 31.6% and employed workers account for 33.3%(Table 4).

Table 5. Comparison of the prevalence of diabetes by age and occupation

Variables	Men						Women						p value
	Total		Non-DM		DM		Total		Non-DM		DM		
	N	%	N	%	N	%	N	%	N	%	N	%	
	7,189	100.0	6,123	85.0	1,066	15.0	9,191	100.0	8,207	89.0	984	11.0	
Age													<0.05
19-39	2,090	29.2	2,044	97.8	46	2.2	2,515	27.4	2,484	98.8	31	1.2	
40-49	1,326	18.4	1,197	90.3	129	9.7	1,767	19.2	1,679	95.0	88	5.0	
50-59	1,333	18.5	1,096	82.2	237	17.8	1,829	19.9	1,645	89.9	184	10.1	
60-69	1,279	17.8	960	75.1	319	24.9	1,607	17.5	1,328	82.6	279	17.4	
70 ≤	1,161	16.1	826	71.1	335	28.9	1,473	16.0	1,071	72.7	402	27.3	
Occupation													<0.05
Manual workers	2,372	33.0	1,968	83.0	404	17.0	1,409	15.3	1,234	87.6	175	12.4	
Non-manual workers	2,143	29.8	1,950	91.0	193	9.0	2,042	22.3	1,984	97.2	58	2.8	
Service/Sales	724	10.1	640	88.4	84	11.6	1,408	15.3	1,275	90.6	133	9.4	

workers												
Housewife, Unemployed	1,950	27.1	1,565	80.3	385	19.7	4,332	47.1	3,714	85.7	618	14.3

* Data are presented as number, P value < 0.05 by chi-square test.
* DM: diabetes mellitus

The prevalence of diabetes measured by age and occupation by gender is shown in Table 4. The prevalence of diabetes is 15.0% for men and 11.0% for women(Table 5).

Both men and women in the 20s and 30s have the lowest prevalence of diabetes at 2.2% and 1.2%, respectively. The prevalence of diabetes in the 60s accounts for 24.9% for men, 17.4% for women, and it accounts for 28.9% for men and 27.3% for women in the 70s. It is shown the prevalence of diabetes increases as the age increases(Table 5).

In the prevalence of diabetes, non-manual workers in men(9.0%) are the lowest and unemployed workers(19.7%) are the highest by occupation. Manual workers in men account for 17.0% and service and sales workers account for 11.6%. Meanwhile, non-manual workers in women(2.8%) are the lowest and unemployed workers(14.3%) are the highest. Manual workers in women account for 12.4% and service and sales workers account for 9.4%(Table 5).

3.3 The risk of diabetes by occupation and assessment the relationship between diabetes and various variables

Table 6. Adjusted Odds Ratios(ORs) for the risk of diabetes by occupation in men and women

Variables	Men			Women		
	OR	95% CI	P-value	OR	95% CI	P-value
Occupation						
Manual workers	1	ref	-	1	ref	-
Non-manual workers	1.02	(0.81 - 1.27)	0.8734	1.09	(0.77 - 1.55)	0.6343
Service/Sales workers	1.03	(0.79 - 1.35)	0.8159	1.29	(1.00 - 1.67)	0.0473
Housewife, Unemployed	0.86	(0.72 - 1.02)	0.0868	1.35	(1.11 - 1.63)	0.0023

* OR, odds ratio; CI, confidence interval.

* Adjusted age, BMI, smoking status, drinking, aerobic physical activity, monthly average household income, and education levels.

After adjusting variables such as age, BMI, smoking, drinking, aerobic physical activity, average monthly household income, and education level, subjects are divided by gender to identify their association diabetes with manual workers, non-manual workers, service and sales workers and unemployed workers respectively and then odds ratios(ORs) by occupation is calculated with multiple logistic regression analyses(Table 6).

Odds ratios(ORs) in men by occupation is: Non-manual workers(OR 1.02, 95% CI 0.81-1.27), Service and Sales workers (OR 1.03, 95% CI 0.79-1.35), and Unemployed workers (OR 0.86, 95% CI 0.72-1.02). The risk of diabetes in service and sales workers in men is 1.03 times higher than that of diabetes in manual workers.

Odds ratios(ORs) in women by occupation is: Non-manual (OR 1.09, 95% CI 0.77-1.55), Service and Sales workers (OR 1.29, 95% CI 1.00-1.67), and Unemployed workers (OR 1.35, 95% CI 1.11-1.63). The risk of diabetes in non-manual workers, services and sales workers and unemployed workers in women is 1.09 times, 1.29 times and 1.35 times higher than that of diabetes in manual workers. As a result, there is a significant difference in service and sales workers in women.

Table 7. Multiple logistic regression to assess the relationship between the risk of diabetes and various variables as well as occupation in men

Variables	Men			
	B	OR	CI	P-value
Occupation				
Manual workers	-	1	Ref	-
Non-manual workers	0.0181	1.02	(0.81 - 1.27)	0.8734
Service/Sales workers	0.0319	1.03	(0.79 - 1.35)	0.8159
Housewife,Unemployed	-0.1516	0.86	(0.72 - 1.02)	0.0868
Age	0.5959	1.81	(1.70 - 1.94)	<0.001
Educational level				
Elementary/Middle school	-	1	Ref	-

High school	0.0377	1.04	(0.87 - 1.24)	0.6808
University ≤	-0.2195	0.80	(0.65 - 1.00)	0.0484
Income				
<250 (Low)	-	1	Ref	-
250-500 (Middle)	-0.2014	0.82	(0.68 - 0.98)	0.0276
500-1500 (High)	-0.2822	0.75	(0.62 - 0.92)	0.0051
Body Mass Index(kg/m^2)				
Underweight	-	1	Ref	-
Normal	1.5230	4.59	(2.11 - 9.98)	0.001
Obese	2.0683	7.91	(3.62 - 17.27)	<0.001
Smoking				
Never	-	1	Ref	-
Smoking	0.2784	1.31	(1.12 - 1.53)	<0.001
Drinking				
Never drink/ low risk	-	1	Ref	-
Drinker	-0.0389	0.96	(0.83 - 1.12)	0.6126
Vigorous physical activity				
None	-	1	Ref	-
Do	-0.1062	0.90	(0.78 - 1.04)	0.1481

* OR, odds ratio; CI, confidence interval; P-value<0.05 by multiple logistic regression. Adjusted age, BMI, smoking status, drinking, aerobic physical activity, monthly average household income, and education level.

In Table 7, multiple logistic regression is performed with independent variables such as occupation, age, education level, monthly average household income, BMI, smoking status, drinking, and aerobic physical activity. The results are represented by coefficient values(B), odds ratios(ORs), a 95% confidence interval(CI).

Odds ratios(ORs) of non-manual workers and service and sales workers are 1.02 and 1.03 respectively, which means non-manual workers and service and sales workers have the risk of diabetes about 1.02 and 1.03 times higher than that of manual workers respectively. In the case of unemployed workers, odds ratio(OR) is 0.86. Odds ratio(OR) at the age is 1.81 and it shows a 1.81 times higher risk of diabetes as age increases. Also, the P-value is lower than 0.001 and it has a statistically significant difference.

At University graduates or higher in the educational level, odds ratio(OR) is 0.80 and the risk of diabetes is 0.80 times lower than elementary or middle school graduates. The P-value is also 0.0484 and it has a statistically significant difference. In the case of monthly average household income, odds ratios(ORs) in middle and high income are 0.82 and 0.75 respectively. The P-value is also 0.0276 and 0.0051 respectively and they have a statistically significant difference.

In the case of BMI, odds ratios(ORs) of normal weight and obesity are 4.59 and 7.91 respectively so the risk of diabetes is 4.59 times higher and 7.91 times higher than that of low weight. Both normal weight and obesity show statistically significant differences. For smokers, the risk of diabetes is 1.31 times higher than for non-smokers, and there is a statistically significant difference. The risk of diabetes was 0.90 times lower when aerobic physical activity

is practiced than when aerobic physical activity is not. However, the P-value is 0.1481 and it has no statistically significant difference.

Table 8. Multiple logistic regression to assess the relationship between the risk of diabetes and various variables as well as occupation in women

Variables	Women			
	B	OR	CI	P-value
Occupation				
Manual workers	-	1	Ref	-
Non-manual workers	0.0850	1.09	(0.77 - 1.55)	0.6343
Service/Sales workers	0.2572	1.29	(1.00 - 1.67)	0.0473
Housewife, Unemployed	0.3001	1.35	(1.11 - 1.63)	0.0023
Age	0.4739	1.61	(1.48 - 1.74)	<0.001
Educational level				
Elementary/Middle school	-	1	Ref	-
High school	-0.1380	0.87	(0.71 - 1.07)	0.1842
University ≤	-0.8074	0.45	(0.33 - 0.60)	<0.001
Income				
<250 (Low)	-	1	Ref	-
250-500 (Middle)	-0.0115	0.99	(0.83 - 1.18)	0.9007
500-1500 (High)	-0.3317	0.72	(0.58 - 0.89)	0.0021
Body Mass Index(kg/m^2)				

Underweight	-	1	Ref	-
Normal	0.9780	2.66	(1.29 - 5.47)	0.0078
Obese	1.7681	5.86	(2.85 - 12.05)	<0.001
Smoking				
Never	-	1	Ref	-
Smoking	-0.0130	0.99	(0.68 - 1.43)	0.9457
Drinking				
Never drink/ low risk	-	1	Ref	-
Drinker	-0.2917	0.75	(0.63 - 0.89)	<0.001
Vigorous physical activity				
None	-	1	Ref	-
Do	-0.1761	0.84	(0.72 - 0.98)	0.0265

* OR, odds ratio; CI, confidence interval; P-value<0.05 by multiple logistic regression. Adjusted age, BMI, smoking status, drinking, aerobic physical activity, monthly average household income, and education level.

In Table 8, multiple logistic regression is performed with independent variables such as occupation, age, education level, monthly average household income, BMI, smoking status, drinking, and aerobic physical activity. The results are represented by coefficient values(B), odds ratios(ORs), a 95% confidence intervals(CIs).

Odds ratio(OR) of non-manual workers is 1.09, which means the risk of diabetes is about 1.09 times higher than that of manual workers. However, the P-value is 0.6343, so it has no statistically significant difference. Odds ratio(OR) of service and sales workers is

1.29, so the risk of diabetes is about 1.29 times higher than that of manual workers. P-value has also a statistically significant difference of 0.0473. In the case of unemployed workers, odds ratio(OR) is 1.35, so the risk of diabetes is 1.35 times higher than that of the manual workers. The P-value is 0.0023 and it has a statistically significant difference. In age, odds ratio(OR) is 1.61 and it indicates a 1.61 times higher risk of diabetes as age increases. The P-value is lower than 0.001, so it has a statistically significant difference.

At university graduates or higher in educational level, odds ratio(OR) is 0.45 and the risk of diabetes is 0.45 times lower than elementary or middle school graduates. The P-value is also lower than 0.001 and it has a statistically significant difference. In the case of monthly average household income, odds ratio(OR) in high income is 0.72 and the risk of diabetes is 0.72 times lower than in the case of low monthly average household income. The P-value is also 0.0021 and it has a statistically significant difference.

In the case of BMI, odds ratio(OR) of normal weight and obesity are 2.66 and 5.86 respectively, so the risk of diabetes is 2.66 times higher and 5.86 times higher than that of low weight. The P-value of normal weight is 0.0078 and the P-value of obesity is also lower than 0.001. Therefore, all of weights have statistically significant differences. The risk of diabetes is 0.84 times lower when aerobic physical activity is practiced than when aerobic physical activity is not. The P-value is also 0.0265 and it has also statistically significant difference.

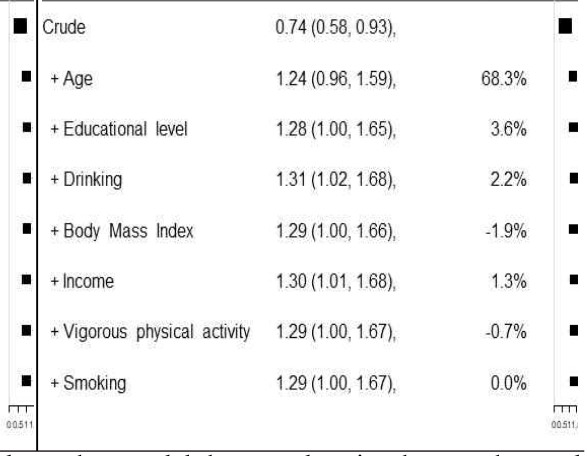
Both men and women have statistically significant differences in age, university graduates or higher in education level, high income in monthly average household income, and normal weight and obesity in BMI. In the case of occupation, there is a statistically significant

difference in service and sales workers in women and in unemployed workers in women. Meanwhile, smoking status in men has a statistically significant difference and for aerobic physical activity in women, there is a statistically significant difference.

3.4 Relative contribution of confounding variables

Table 9. Odds Ratios(ORs) for the prevalence of diabetes associated with occupational category and percent change by addition of potential confounding variables.

Men			Women		
Variables	**OR (95% CI)**	**Change, %**	**Variables**	**OR (95% CI)**	**Change, %**
Crude	0.64 (0.50, 0.82),		Crude	0.74 (0.58, 0.93),	
+ Age	1.00 (0.77, 1.30),	56.1%	+ Age	1.24 (0.96, 1.59),	68.3%
+ Educational level	1.04 (0.80, 1.36),	4.1%	+ Educational level	1.28 (1.00, 1.65),	3.6%
+ Income	1.05 (0.81, 1.37),	1.3%	+ Drinking	1.31 (1.02, 1.68),	2.2%
+ Smoking	1.04 (0.80, 1.36),	-1.2%	+ Body Mass Index	1.29 (1.00, 1.66),	-1.9%
+ Body Mass Index	1.03 (0.79, 1.35),	-0.8%	+ Income	1.30 (1.01, 1.68),	1.3%
+ Vigorous physical activity	1.03 (0.79, 1.35),	0.1%	+ Vigorous physical activity	1.29 (1.00, 1.67),	-0.7%
+ Drinking	1.03 (0.79, 1.35),	0.0%	+ Smoking	1.29 (1.00, 1.67),	0.0%



* When a new factor adjusted is added to the model by gender, it shows changed odds ratios(ORs) between diabetes and service and sales workers. They are indicated as OR, Change(%)

In Table 9, when sequentially, each variable is added to the model with step-wise way, the changes(%) in effect estimates are calculated. Among the remaining variables, only one variable that the largest change is caused at each step is added to the model [22]. The results are as follows:

In Table 9, odds ratio(OR) between diabetes and service and sales workers in men is 0.64. Firstly, age is added as a new factor, so odds ratio(OR) of service and sales workers becomes 1.00 (+56.1%

change). Secondly, education level is added as the next factor, which resulted in 1.04 (+4.1% change) odds ratio(OR) for the service and sales workers. Thirdly, income is added as the next factor, which resulted in 1.05 (+1.3% change) odds ratio(OR) for the service and sales workers. And then, four new factors(smoking, Body Mass Index, vigorous physical activity, and drinking) are added subsequently. Finally, final odds ratio(OR) is 1.03.

In Table 9, odds ratio(OR) between diabetes and service and sales workers in women is 0.74. Firstly, age is added as a new factor, so odds ratio(OR) of service and sales workers becomes 1.24(+68.3% change). Secondly, education level is added as the next factor, which resulted in 1.28(+3.6% change) odds ratio(OR) for the service and sales workers. Thirdly, drinking is added as the next factor, which resulted in 1.31(+2.2% change) odds ratio(OR) for the service and sales workers. And then, four new factors(income, Body Mass Index, vigorous physical activity, and smoking) are added subsequently. Finally, the final odds ratio(OR) is 1.29.

Both men and women have the highest rate of change in odds ratio(OR) of service and sales workers when age is added as a new factor, and then education level is added.

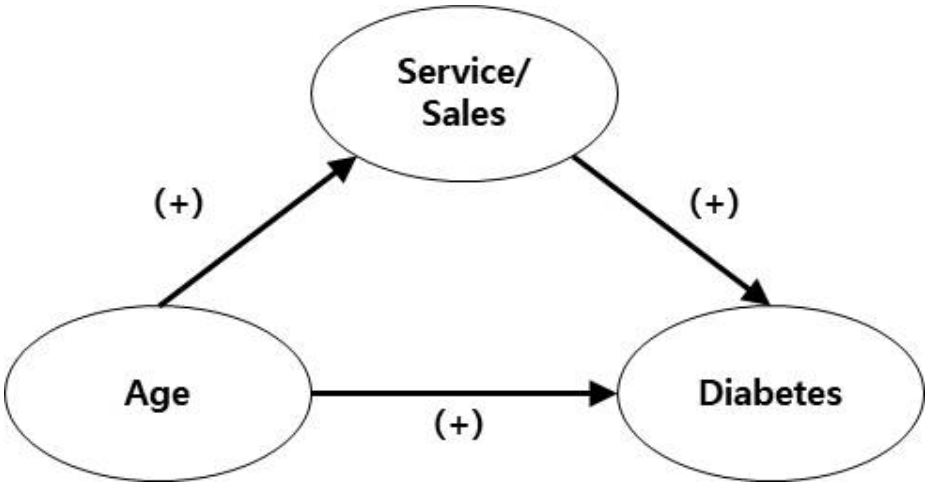


Figure 4. Directed Acyclic Graph(DAG) of the relationship between occupation, age and diabetes

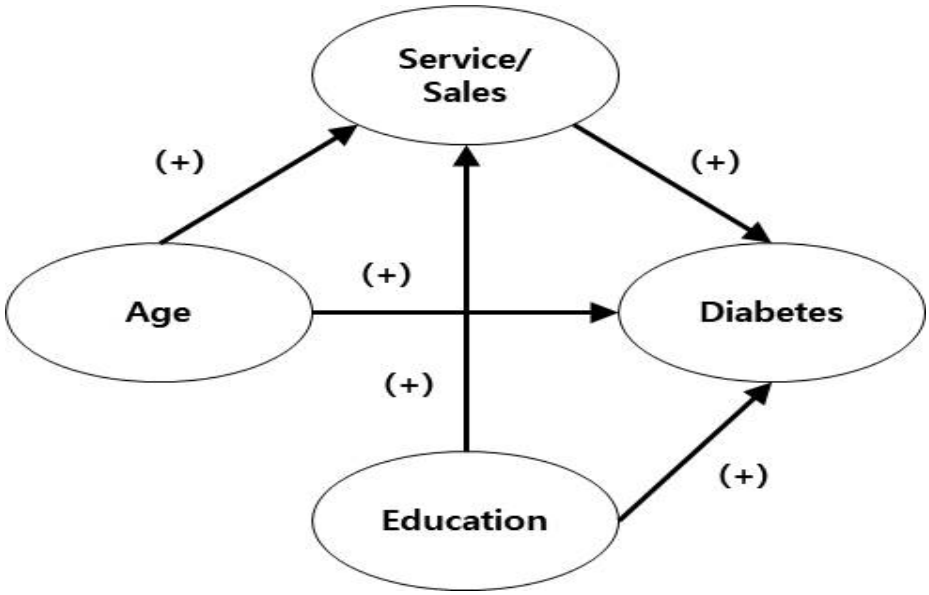


Figure 5. Directed Acyclic Graph(DAG) of the relationship between occupation, age, education level and diabetes

In Figure 4 and 5, the first and second factors with high odds ratios(ORs) among the relative contributing factors to diabetes identified in Table 9 are represented with DAGs, based on relationship between the risk of diabetes and the each variable identified in Table 7 and 8.

In Figure 4 based on Table 9, age contributes to increasing the risk of diabetes in the service and sales workers greatly in both men and women. Odds ratio(OR) of the service and sales workers for the prevalence of diabetes is 0.64 in men. Odds ratio(OR) of the service and sales workers becomes 1.00 with the addition of the age variable, and odds ratio(OR) is increased by 56.1%. On the other hand, in women, odds ratio(OR) of the service and sales workers for the prevalence of diabetes is 0.74. Odds ratio(OR) of the service and sales workers becomes 1.24 with the addition of the age variable, and odds ratio(OR) is increased by 63.8%. That is, the risk of diabetes rises in the positive direction by adding age.

In Figure 5 based on Table 9, in both men and women, education level contributes to increasing the risk of diabetes in the positive direction after an age factor is first added. In the case of men, the risk of diabetes increases by OR 1.04(+4.1% change) with the addition of education level after an age factor is added. On the other hand, in women, the risk of diabetes increases in the positive direction by OR 1.28(+3.6% change) with the addition of education level after an age factor is added(Table 9).

3.5 Various effect modifications between variables and occupations

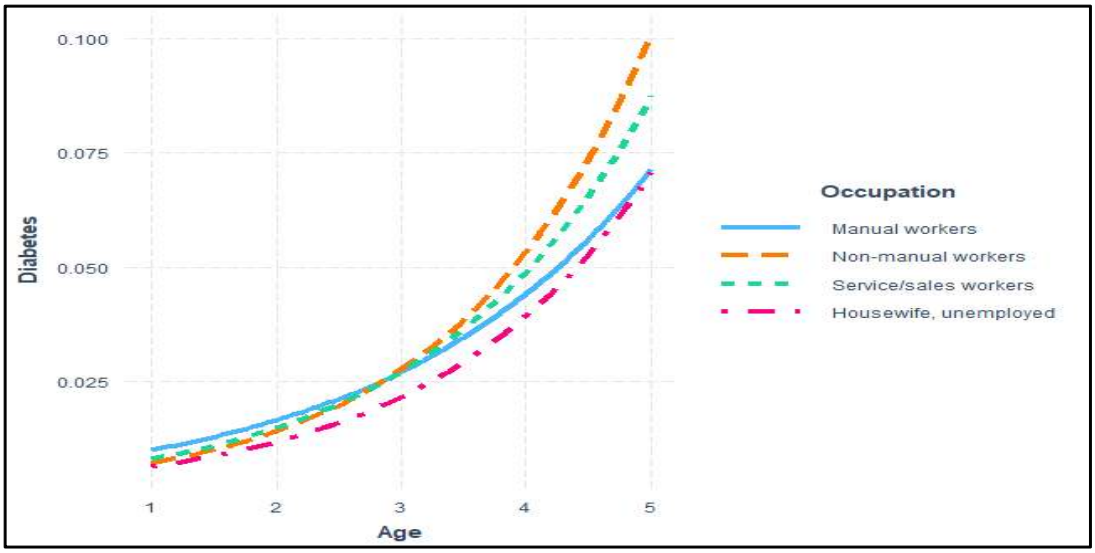


Figure 6. Predicted probability of diabetes by effect modification between age and occupations in men

* Age: 1(20s-30s), 2(40s), 3(50s), 4(60s), 5(70s≤)

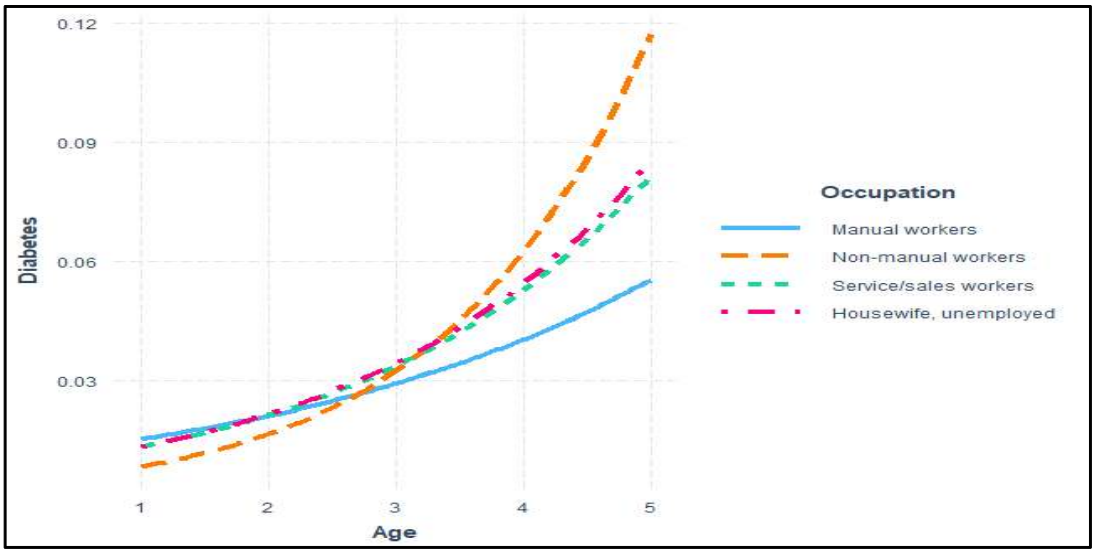


Figure 7. Predicted probability of diabetes by effect modification between age and occupations in women

* Age: 1(20s-30s), 2(40s), 3(50s), 4(60s), 5(70s≤)

Figure 6 and 7 show the risk of diabetes by effect modification between age and occupations. For Figure 6, the risk of diabetes is increased with age in all four occupations in men. Especially, non-manual workers in men have the highest risk of diabetes as age increases. For Figure 7, the risk of diabetes is also increased with age in all four occupations in women. In addition, non-manual workers have the highest risk of diabetes like men.

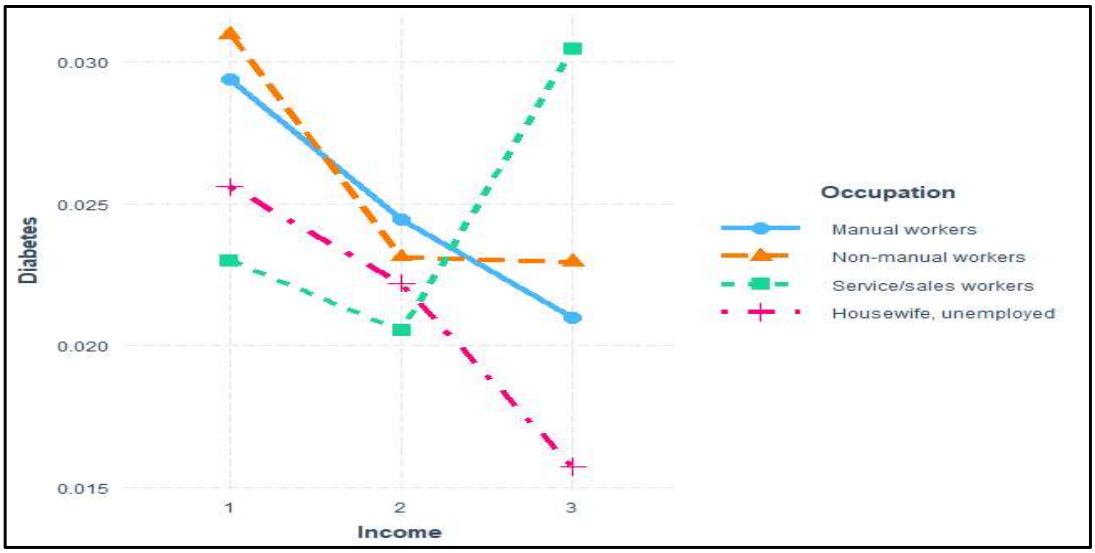


Figure 8. Predicted probability of diabetes by effect modification between income and occupations in men

* Income: 1(less than 2.5 million won), 2(more than 2.5 million won to less than 5 million won), 3(more than 5 million won to 15 million won)

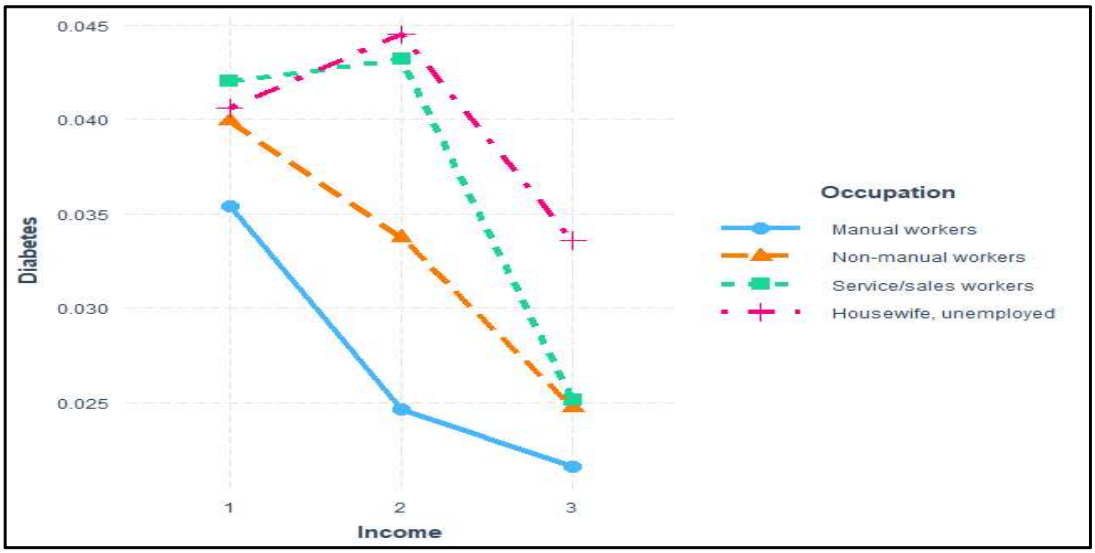


Figure 9. Predicted probability of diabetes by effect modification between income and occupations in women

* Income: 1(less than 2.5 million won), 2(more than 2.5 million won to less than 5 million won), 3(more than 5 million won to 15 million won)

Figure 8 and 9 show the risk of diabetes by effect modification between income and occupations. For Figure 8, the risk of diabetes is decreased when income is increased in three occupations except for service and sales workers in income level 3. Of Service and Sales workers, the risk of diabetes decreases in income level 1 to 2, but the risk of diabetes is increased when income increases to income level 3. This is a problem of the proportion of diabetes composition by income level. Therefore, it should be careful about interpretation.

For Figure 9, the risk of diabetes is dramatically decreased in all of occupations when income is increased. Especially, when the income level is changed from 1 to 2 in manual workers and when the income level is changed from 2 to 3 in service and sales workers, the risk of diabetes is drastically decreased.

Of service and sales workers and unemployed workers, the risk of diabetes increases in income level 1 to 2, but the risk of diabetes is decreased when income increases to income level 3. This is a problem of the proportion of diabetes composition by income level. Hence, it should be careful about interpretation.

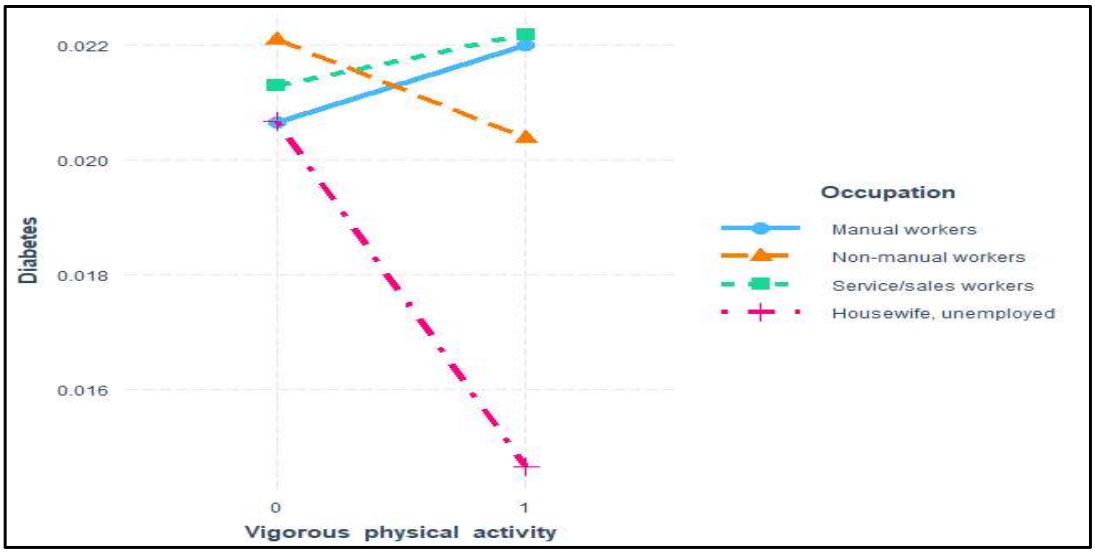


Figure 10. Predicted probability of diabetes by effect modification between vigorous physical activity and occupations in men

* Vigorous physical activity: None(0), Do(1)

Figure 10 shows the risk of diabetes by effect modification between aerobic physical activity and occupations. In non-manual workers and unemployed workers, the risk of diabetes is decreased when aerobic physical activity is performed. However, in manual workers and service and sales workers, the risk of diabetes is increased when aerobic physical activity is conducted. This is a problem of the proportion of diabetes composition by aerobic physical activity level, so it should be careful about interpretation.

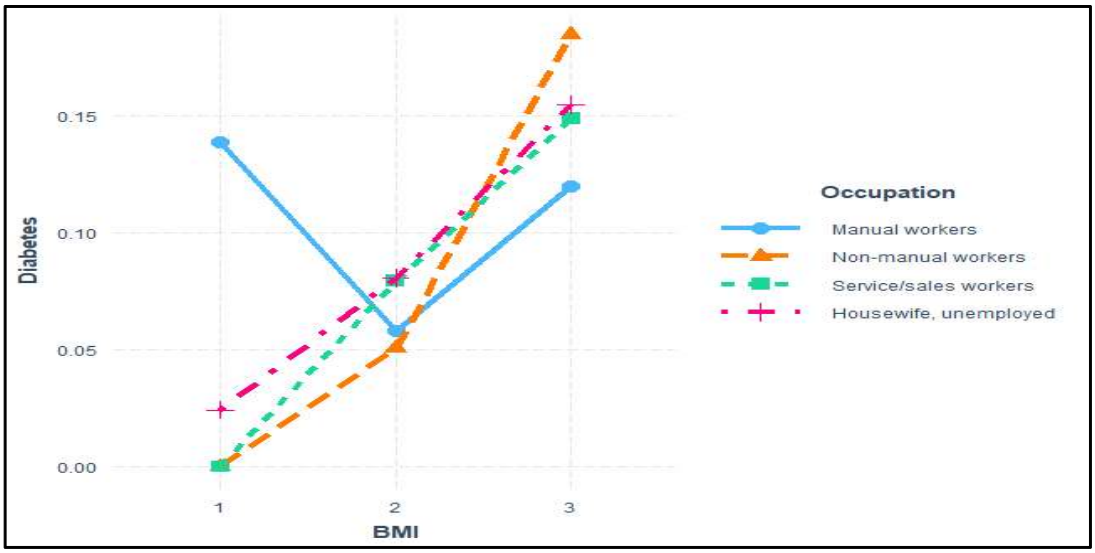


Figure 11. Predicted probability of diabetes by effect modification between BMI and occupations in women

* BMI: underweight=1 (<18.5 kg/㎡), normal=2 (18.5 kg/㎡≤ BMI <25.0kg/㎡), obesity=3 (25.0 kg/㎡≤ BMI)

Figure 11 shows the risk of diabetes by effect modification between BMI and occupations. In all of occupations except for manual workers in BMI level 1 to 2, the risk of diabetes is increased as BMI is increased. In non-manual workers, the higher the BMI is, the higher the risk of diabetes is dramatically. However, in the case of the manual workers, the risk of diabetes in BMI level 2 is reduced than in BMI level 1. This is a problem of the proportion of diabetes composition by BMI level. Therefore, it should be careful about interpretation.

As a result, in both men and women, there are effect modifications between age and occupations and between income and occupations respectively. Also, there are effect modifications between physical activity and occupations in men and between BMI and

occupations in women respectively. Therefore, for all occupations, age, income and physical activity contribute to diabetes in men, and age, income and BMI contribute to diabetes in women.

Chapter 4. Discussion and Conclusion

4.1 Discussion

As a result of this study, the prevalence rate of diabetes in men was 15.0% and 11.0% in women. The prevalence of diabetes in men was higher than in women. Also, in both men and women, the risk of diabetes was increased as age was increased. The prevalence of diabetes for men in a previous study [8] was 15.4% and that of females was 11%. when it is compared with the results of this study, the prevalence of diabetes in 2016 - 2018 tended to decrease or maintain somewhat.

In terms of the prevalence of diabetes by occupation, non-manual workers (managers, professionals and related workers and clerks) in men were the lowest at 9.0%. Conversely, unemployed workers in men were the highest at 19.7%. For women, non-manual workers were the lowest at 2.8% and the highest at 14.3% in unemployed workers.

In the previous study [8], the prevalence of diabetes in unemployed workers was the highest in both men and women at 25.6% and 14.6% respectively. In men, the prevalence of diabetes in professional and administrator was the lowest at 7.9%, followed by office workers (9.9%). This is consistent with the low prevalence of diabetes in the non-manual workers of this study in men. However, in the study [8], the prevalence of diabetes in office workers in women was 2.2% and professional and administrator had a low

prevalence rate(2.3%), which is somewhat different from this study.

In this study, for men, there were no significant differences in occupation when adjusting variables such as age, BMI, smoking, drinking status, aerobic physical activity, average monthly household income, and education level and then conducting multiple logistic regression analyses. However, in women, the risk of diabetes was 1.29 times higher in service and sales workers when compared to manual workers. The P-value was 0.0473, which is a statistically significant difference. In addition, unemployed workers in women were 1.35 times more risky to diabetes when compared to manual workers.

The previous study [8] shows that the risk of diabetes was more than twice as high in service and sales workers and salesman and agriculture, forestry and fishy workers in men than professional occupation. Also, administrator in women had high odds ratios but it was not a significant result. These results are different from this study. The reason is because the adjusted variables were different. Especially, this study included adjusted variables, ''BMI'' and ''physical activity'' related to diabetes significantly. Therefore, study results should be careful about interpretation.

In another study [12], the risk of diabetes was 2.089 times higher for service workers than for elementary workers, followed by clerks and managers. In addition, when reclassified and analyzed according to the degree of manual labor, non-manual workers had a higher risk of diabetes when compared to manual workers. The other study [19] shows a high risk of diabetes in service and sales workers, which is a similar result with this study. Also, the study [19] had a high risk of odds ratio(OR) in other occupations. However, the study [19] did not analyze by gender because there was a big difference in composition ratio between men and women. On the

other hand, this study differs in that it has a similar composition ratio between men and women of this study subjects and in that it was classified and analyzed by gender. Therefore, the results of the risk of diabetes by occupations were somewhat different because there were differences in the prevalence of diabetes by gender.

The novelties of this study are as follows: Firstly, the relative contributing factors of confounding variables was explored in service and sales workers with high risk of diabetes. As a result, age contributed the most to the risk of diabetes in service and sales workers in both men and women, followed by education level in both men and women.

When the service and sales workers are divided in detail, the jobs for young people at 20s and 30s are quite different from middle-aged people at 50s. Meanwhile, in women, the ratio of service and sales workers at 20s and 30s and the ratio of them at 50s are similarly high. Therefore, the age effect to diabetes seems to be greatly calculated as age increases. Also, education level in service and sales workers contributed to diabetes. It is guessed because there are a large number of middle-aged people at 50s in service and sales workers, who are relatively less educated than young people at 20s and 30s. After all, it is also related to socioeconomic status and it eventually affects the risk of diabetes.

In addition, when age and education work together, the risk of diabetes was greater. That is, service and sales workers with high age and low education level were relatively higher at risk of the diabetes than young service and sales workers with high education level. Meanwhile, the effects of BMI in service and sales workers were not relatively significant.

Secondly, various effect modifications among variables were

explored. In men, age, income and physical activity contributed to the risk of diabetes in all occupations. Also, in women, age, income, and BMI contributed to the risk of diabetes in all occupations. In common with men and women, age and income contributed to diabetes.

In both men and women, the risk of diabetes increased as the age increased within all occupations. In particular, non-manual workers in women increased the risk of diabetes sharply as age was increasing, compared to other occupations. Also, for both men and women in all occupations, the higher the income was, the lower the risk of diabetes was. Especially, for women in service and sales workers, the higher the income was, the lower the risk of diabetes was.

To sum it up, the study shows service and sales workers in women were found to be vulnerable to diabetes, but women in service and sales workers with high income were lower at the risk of diabetes. The results can explain that the incidence of diseases depending on socioeconomic status (SES) is also different. Also, in women, the risk of diabetes increased as BMI increased in all occupations. Especially in women, non-manual workers have a significantly higher risk of diabetes when compared to other occupations. It is thought to be related to working patterns like long sitting time.

According to the Korea Labor Institute (KLI), Korea has a much larger women population than men in the service and sales industry. In addition, there are a large number of woman sales service workers in their 40s and 50s, who are generally low-educated and low-paid irregular workers. In other words, non-regular woman workers, who are relatively older than other occupations and have lower socioeconomic levels, work in service and sales. That is why

women in service and sales can be vulnerable to diabetes. In addition, low wages and long hours of workers affect obesity due to unhealthy and irregular eating, which poses the risk of diabetes.

The industry of service and sales is steadily developing, but working conditions and quality of employment seem to be insufficient. In order to prevent and manage diabetes, more researches are needed to derive specific policy directions to improve the treatment of services and sales in women.

The strengths of this study are as follows: Firstly, the number of study population and patients with diabetes were sufficient. Also, when gender was divided, the composition ratio of men and women was similar, which properly reflects the characteristics of men and women in analysis. Secondly, various variables were adjusted to reduce potential biases. Also, important variables affecting diabetes which were not adjusted in previous studies were also adjusted. In addition, the basic variables such as smoking, drinking, and physical activity of the Korea National Health and Nutrition Examination Survey data were reconstructed in more detail and reflected in this study.

A limitation of this study is that first of all, it cannot be explained exactly about causality between occupation and diabetes because it is a cross-sectional study. Also, the working period is unknown and detailed differences within each occupation cannot be known because it is simply comparison by occupational groups. Lastly, diet and nutrition were not addressed in this study because important factors related to diabetes, such as glycemic load, glycemic index, and glucose etc, is not included in this data.

4.2 Conclusion

In this study, the 7th Korea National Health and Nutrition Examination Survey data (2016-2018) were used to identify the prevalence of diabetes and the risk of diabetes by gender. One of key findings in this study is that the service and sales workers in women are more vulnerable to diabetes. According to the distribution of service and sales workers in this study, 66.0% of women and 34.0% of men are service and sales workers. That is, the number of women in service and sales workers is higher than that of men. Considering that service and sales workers in women are vulnerable to diabetes, understanding related to public health and management for women in this occupation are needed.

Age and education level relatively contributed to the risk of diabetes in service and sales workers in women. Also, income contributed to the risk of diabetes in all occupations in both men and women. This suggests that socioeconomic levels affect the risk of diabetes, and that the disease is not fair to people. Therefore, efforts in the workplace are needed for workers with low socioeconomic levels with diabetes.

Diabetes is a chronic disease that requires active prevention and steady management because it causes comorbidity or complication. In order to reduce and prevent the incidence of diabetes as well as the management of patients with diabetes, more understanding and an epidemiologic research about the groups with high prevalence of diabetes are needed.

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국문초록

직업군에 따른 당뇨 유병률의 격차와 기여요인: 국민건강영양조사 2016-2018

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연구 배경 및 목적: 전 세계적으로 당뇨는 꾸준히 증가하고 있는 공중보건 문제이다. 한국도 마찬가지로 지난 수년간 당뇨는 증가하고 있으며, 이는 중요하게 다루어야 할 만성질환이다. 그동안 당뇨에 위험요인을 밝히는 연구들은 많이 있었다. 그러나 상대적으로 당뇨와 직업과의 관련성을 논의한 연구들은 많지 않다. 산업이 발전하고, 산업구조가 변화하면서 직업군은 많은 변화를 겪고 있다. 이러한 변화가 당뇨의 추세와 연관이 있다면 그 관계를 찾아내어 충분히 대응하여야 한다. 따라서 본 연구의 목적은 당뇨에 취약한 직업군을 밝혀내고, 직업군에 따라 당뇨에 영향을 주는 요인들을 발견하는 것이다.

연구방법: 국민의 건강행태, 만성질환 유병현황, 식품 및 영양섭취실태에

관한 법정 조사인 국민건강영양조사 자료를 이용하여 2016년부터 2018년까지 수행된 최근 3년 자료를 분석하였다. 연구 대상자는 검진과 설문에 참여한 16,380명으로 (만)19세 이상 성인을 대상으로 하였다. 남성은 7,189명, 여성은 9,191명이다. 연령은 20-30대, 40대, 50대, 60대, 70대 이상으로 분류하였다. 직업 분류는 국제노동기구의 국제 표준 직업 분류를 기초로 만들어진 한국표준직업분류를 기준으로 나누었으며, 본 연구에서는 직업 성질에 따라 생산직, 사무직, 서비스 및 판매직, 무직으로 재분류하였다. 당뇨 기준은 공복혈당이 126mg/dL 이상이거나, 의사진단을 받았거나 혈당강하제 복용 혹은 인슐린 주사를 투여 받고 있는 경우로 정의하였다. 직업 간 당뇨 유병률의 차이를 보기 위해 카이-제곱 검정 분석을 하였으며, 당뇨 유병률의 교차비를 알아보기 위해 여러 변수들을 보정한 후 다중 로지스틱 회귀분석을 시행하였다. 결과는 오즈비와 95% 신뢰구간을 제시하였다. 또한, 당뇨 위험에 상대 기여요인과 교호작용도 분석하였으며, 위 통계분석은 R ver. 4.0.3을 사용하였다.

연구결과: 직업군에 따른 당뇨 유병률은 남성의 경우, manual(odds ratio[OR] 1.00, 95% confidence interval[CI] ref), non-manual(OR 1.02, 95% CI 0.81-1.27), service and sales(OR 1.03, 95% CI 0.79-1.35), unemployed workers(OR 0.86, 95% CI 0.72-1.02)였다. 여성의 경우, manual(OR 1.00, 95% CI ref), non-manual(OR 1.09, 95% CI 0.77-1.55), service and sales(OR 1.29, 95% CI 1.00-1.67), unemployed workers(OR 1.35, 95% CI 1.11-1.63)였다. 그 결과, 남성에서는 통계적으로 유의한 직업군을 발견하지 못하였고, 여성에서는 서비스 및 판매직(P-value, 0.0473)과 무직(P-value, 0.0023)이 통계적으로 유의했다. 또한, 서비스 및 판매직에서 연령과 교육수준이 상대적으로 당뇨 위험에 높게 기여하였다. 모든 직업군에 관하여, 남성에서는 나이, 소득, 신체활동이 당뇨에 기여하였으며, 여성에서는 나이, 소득, BMI가 당뇨에 기여하였다.

결론: 본 연구에서는 직업군에 따라 당뇨 위험도의 차이를 분석하였으며, 여성 서비스 및 판매직에서 당뇨 위험이 높고, 상대적으로 연령과 교육수준이 당뇨 위험에 크게 기여한다는 사실을 밝혀냈다. 또한, 모든 직

업군에서 소득수준이 당뇨 위험에 기여하고 있다. 본 연구 결과를 바탕으로 서비스 및 판매직에 종사하는 여성들의 건강을 관리하고 예방할 것을 제안한다. 또한, 사회경제적 수준이 낮고, 당뇨가 있는 근로자들을 위해 사업장 내 개선을 제안한다.

주요어: 당뇨, 직업, 유병률, 교호작용
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