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Cardiovascular Disease Risk Factors Related to Shift Work among Korean Workers Aged from 30 to 49 Years

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Abstract

This study was to compare health behaviors between day workers (DW) and shift workers (SW), and to investigate the cardiovascular disease (CVD) risk factors among 30-49 years Korean workers. SW showed higher prevalence of smoking than DW.The proportion of adequate sleep was lower in SW than in DW. DW showed higher prevalence of impaired fasting glucose, however, there were no significant differences in hypertension, obesity, hypercholesterolemia, and metabolic syndrome between DW and SW. Further research is recommended to include mediating factors such as organizational culture or working time, etc., for scrutinizing the association between work type and CVD risk factors.

Key words: Shift work, Cardiovascular disease, Cross-sectional studies

1. Introduction

The industrial revolution has had a significant impact on the life of people. The introduction of electric light and other technologies expanded possibilities of nighttime activities. This trend made it possible to do nighttime operation in both manufacturing and service sectors, which resulted in various working patterns such as long working hours, shift work, and graveyard shift [1]. With increasing economic and social demands, a 24-hour operating society created obstacles to obtaining adequate sleep and about 20% of workers have been made to do shift work [2]. The increasing use of cell phones, computers and the internet at work has had the effect of putting some workers in a perpetual "on-call" status, as people literally bring their laptops to work, then go to bed with them [1].

Shift work is also associated with negative health outcomes and safety issues, including high risk of hypertension, dyslipidemia, glucose intolerance, ischemic heart disease, and cancer [3,4]. However, studies of shift work and chronic diseases didn't show consistent results [5], which can be expected that influences of shift work on health status vary in different nations. Actually working hours of workers in Korea is the longest in the OECD country [6]. Prolonged working hours reduce sleep hours [7] and increase the risk of

cardiovascular diseases (CVD) [8]. In addition, work organizational culture and working environment including working conditions can cause various stress, thus have an impact on workers' leisure activities and physical and mental health behaviors such as smoking or alcohol intake [9,10].

On the other hand, the age is another factor that affects job security and the incidence of CVD. Workers with the age of older than 50 feel pressure that they may get retired early without their intention and experience anxiety regarding job security[11]. This anxiety toward involuntary early retirement can be a stressor leading to a CVD. Therefore, this study analyzed the relationship between shift work and CVD risk factors. The study has included only the subjects whose age was between 30 and 49 years because CVD risk factors such as metabolic syndrome, hypertension, and diabetes generally appeared at these ages.

There has few research regarding influences of shift work on CVD risk factors of workers in Korea even though shift work is getting increased. Accordingly, it is needed to examine the association between shift work and CVD risk factors of workers in Korea.

2. Subjects and Methods

2.1 Study design and data set

This study was a secondary analysis design based on the Korean National Health and Nutrition Examination Survey (KNHANES), a cross-sectional and nationally representative survey performed from 2008 to 2012. The survey used a stratified multistage probability sampling design, and consisted of health survey, health examination, and nutritional interview. Of the 40, 895 entire participants of survey, 4,291 adults aged between 30 and 49 who were employed, and responded main questions regarding types of work and health examination were included.

2.2. Measurement and data collection

Types of work was asked "Do you usually work at day time (between 6 am and 6 pm), or work at different hours?" Among participants' responses, work at day time for the most part was categorized into day work. Evening shift, night shift, regular day-night rotating shift, 24 hour shift, split shift (2 more different working time zone in a day), and irregular rotating shift were categorized into shift work. Participants who answered 'others' for these questions were excluded because they could not be categorized.

Sociodemographic data included gender, age, education level, marital status, and occupation. The age was divided into 30s and 40s. Occupational status was divided into four

categories which were based on the Korean Standard Occupational Classification System.

Health behaviors included current smoking, alcohol consumption, sleep duration, physical activity, and perceived stress. Alcohol consumption was assessed by questions about average alcohol consumption during the past year, and participants were categorized into non-high risk drinking and high risk drinking. High risk drinking means a man drinks more than 61g alcohol (7 glasses or more) and a woman drinks more than 41g alcohol (5 glasses or more) at a time twice or more per week. Sleep duration was defined as the response to the question: "How many hours do you usually sleep?" Participants who responded ≤ 6 h sleep were defined as a "short sleeper" as reported by the International Classification of Sleep Disorders definition [12].

Health examination was included as below. Body mass index (BMI) and waist circumference were measured for anthropometric data. BMI was calculated by dividing the weight (kg) by the square of the height (m). BMI was categorized into four groups: underweight (< 18.5 kg/m^2), normal (18.5 to 22.9 kg/m^2), overweight (23.0 to 24.9 kg/m^2), and obese (≥ 25.0 kg/m^2). Venous blood samples were collected from each participant in the morning after overnight fasting for at least 8 h.

CVD risk factors included prehypertension, hypertension, impaired fasting serum glucose (IFG), diabetes, central obesity, hypercholesterolemia, and metabolic syndrome. Prehypertension was defined as systolic pressure (SBP) 120-139 mmHg or diastolic pressure (DBP) 80-89 mmHg [13]. Hypertension was defined as SBP ≥ 140 or DBP ≥ 90 mmHg or regular use of antihypertensive medication. IFG was defined as 100 ≤ fasting serum glucose ≤ 125mg/dL. Diabetes was defined as fasting serum glucose ≥ 126mg/dL or the use of hypoglycemic agent or insulin therapy. Hypercholesterolemia was defined as serum total cholesterol ≥ 240 mg/dL or taking medication to reduce serum cholesterol. Central obesity was defined as waist circumference 90cm or more in male and 85cm or more in female [14]. The indicator of metabolic syndrome is central obesity, which is defined as abdominal circumference of 90cm or more in males and 85cm or more in females. Using 2009 Joint Scientific Statement [15], metabolic syndrome is defined with three or more abnormal criteria out of five components including hypertriglyceridemia, elevated blood pressure, central obesity, lowered high density lipoprotein (HDL), elevated fasting serum glucose.

2.3. Data analysis

All statistical analyses were performed with SAS software version 9.2 (SAS institute, Cary, NC). The alpha level for statistical significance was set at $p < 0.05$. To represent Korean

population, the sampling weights assigned to participants were applied to all analyses. Sampling weights were generated by considering sample design, non-response rate of the target population, and post-stratification. Differences between day workers and shift workers were analyzed by the Student's t-test or the Chi-square test.

3. Results and Discussion

3.1. Prevalence of shift workers

Table 1 demonstrates general characteristics of day workers and shift workers. Shift workers were composed of 17.0% of the entire participants, showing significant differences in marital status and occupation. According to marital status, proportion of shift workers was 23.0% in unmarried workers, 17.5% in separated/divorced, and 16.2% in married workers (p = 0.001). There are few reports regarding influences of shift work on family or social life. However, married people generally have more social roles than unmarried people, which possibly explains that day work is more preferred by married people than people who are single [16].

Table 1. General characteristics between day worker and shift worker

Variables	Category	Day Worker (N=3561)		Shift Worker (N=730)		All (N=4291)		X^2	p
		n	%	n	%	n	%		
Gender	Male	2020	83.1	412	16.9	2432	56.7	0.02	0.887
	Female	1541	82.3	318	17.1	1859	43.3		
Age group	30~39 y	1689	83.4	337	16.6	2026	47.2	0.39	0.532
	40~49 y	1872	82.7	393	17.4	2265	52.8		
Education	Elementary	71	83.5	14	16.5	71	2.0	1.18	0.757
	Middle	187	85.4	32	14.6	185	5.1		
	High school	1417	82.5	300	17.5	1453	40.0		
	College~	1886	83.1	384	16.9	1945	52.9		
Marital status	Unmarried	379	77.0	113	23.0	492	11.5	14.17	0.001
	Married	3031	83.9	585	16.2	3616	84.3		
	Separated/Divorced	151	82.5	32	17.5	183	4.3		
Occupation	Professional/manager	1003	80.2	247	19.8	1250	29.3	118.46	<0.001
	Office worker	821	94.7	46	5.3	867	20.3		
	Sales/Service	692	76.5	213	23.5	905	21.2		
	Physical worker	1029	82.3	222	17.8	1251	29.3		

Among types of occupation, proportion of shift workers was 23.5% in sales/service, 19.8%

in professional/manager, and 17.8% in physical work. Every country has different characteristics of industries and there are only few studies about shift work relating to the occupation type. However, a study in Finland for workers with age 40 to 45 showed the shift work rate was highest in physical work and sales/service and lowest in office work, which was similar to this study result [17].

3.2. Health behaviors between day workers and shift workers

In comparison of health behaviors, shift workers smoked more than day workers (35.6% vs. 31.4%; $p < 0.001$) (Table 2). Some previous studies reported that shift workers had higher drinking and smoking rates and lower rate in regular exercise than day workers [18, 19]. Another study reported no difference in smoking rates between day and shift workers [20]. The other study stated that the prevalence of shift work, the smoking rate, and the drinking rate were different significantly by occupation [19]. Health risk behaviors are associated with demographic and job characteristics such as gender, age group, job, or work type [21,22]. Therefore, we need to consider the background of shift workers while we do research on the association between shift work and health risk behaviors.

Table 2. Health behavior between day workers and shift workers

Variables	Category	Day Worker (N=3561)		Shift Worker (N=730)		All (N=4291)		X^2	*P*
		N	%	N	%	N	%		
Current smoking	No	2442	68.6	470	64.4	2912	67.9	5.02	0.025
	Yes	1116	31.4	260	35.6	1376	32.1		
High-risk drinking	No	2586	80.2	532	80.6	3118	80.3	0.05	0.816
	Yes	638	19.8	128	19.4	766	19.7		
Sleep duration	≤6 h	1398	39.3	290	39.8	1688	39.4	6.95	0.031
	7~8 h	2022	56.9	396	54.3	2418	56.4		
	≥9 h	136	3.8	43	5.9	179	4.2		
Moderate physical activity	No	3261	91.7	669	91.6	3930	91.7	0.00	0.994
	Yes	297	8.4	61	8.4	358	8.4		
Walking over 30min daily	No	2298	64.6	487	66.8	2785	65.0	1.26	0.261
	Yes	1258	35.4	242	33.2	1500	35.0		
Perceived stress	Little	2413	67.8	520	71.2	2933	63.4	3.30	0.069
	much	1146	32.2	210	28.8	1356	31.6		

Sleep duration was different between two groups: The proportion of short sleep or long sleep was higher in shift workers than in day workers. Generally, Shift workers commonly

complain of poor sleep by disturbing circadian rhythm of workers [23]. Short-sleep duration was reported to strongly associate with shift work [24]. Most previous studies focused on short sleep of shift workers [23,25], however, shift workers of these participants showed a little bit higher prevalence of long sleepers (≥ 9hr/sleep) than day workers. Sleeping against circadian rhythm might disturb sound sleep, it may bring about long sleep for the shift worker.

However, drinking habits, physical activities and perceived stress were not different between groups.

3.3. Cardiovascular disease between day workers and shift workers

Table 3 compares blood pressure and blood tests of day workers and shift workers. Average fasting serum glucose level was 95.3 mg/dL in day workers and 93.2 mg/dL in shift workers, which showed significantly higher in day workers (p = 0.004). However, there were no significant differences between day workers and shift workers regarding systolic and diastolic blood pressure, cholesterol, triglyceride, HDL, BMI, and waist circumferences.

Table 3. Comparison biochemical and phyiological indicators between day workers and shift workers

Variables	Day workers	Shift workers	t	p
Systolic BP, mmHg	113.5±14.1	114.1±14.3	-1.05	0.296
Diastolic BP, mmHg	76.4±10.8	76.6±11.2	-0.39	0.697
Fasting serum glucose, mg/dL	95.3±19.3	93.2±17.5	2.89	0.004
Total cholesterol, mg/dL	189.4±34.6	190.2±35.6	-0.58	0.559
Triglyceride, mg/dL	137.2±117.2	133.8±114.1	0.71	0.478
HDL, mg/dL	52.5±12.3	12.6±0.5	-1.49	0.136
LDL, mg/dL	117.1±31.4	115.0±33.4	0.88	0.380
BMI, kg/m^2	23.9±3.4	23.8±3.5	0.23	0.817
Waist circumference	81.0±9.9	81.1±9.9	-0.22	0.824

BP; blood pressure, HDL; high-density lipoprotein, LDL; low-density lipoprotein, BMI; body mass index

Table 4 compares the prevalence of CVD risk factors between day workers and shift workers. Day workers with IFG and diabetes mellitus were 18.7% and 4.2%, respectively while shift workers with IFG were 15.5% and 3.4% of them were diabetes (p = 0.018). In other words, day workers had significantly IFG level compared to shift workers. Previous studies showed shift workers had higher risks of metabolic diseases and diabetes [20,26]. In Korea, employees are forced to work overtime frequently and to have informal meetings often with coworkers after work [27]. This organizational culture is regarded as a kind of

continuous work to employees, so day workers are swamped with frequent overtime work or involuntary meeting after work. Besides, Korean workers are required to achieve great labor productivity with minimal manpower in unlimited competition, thus face diverse problems such as heavy workload and competitions [9]. The reason why Korean day workers have higher morbidity rate of IFG and diabetes than shift workers is probably related to this kind of organizational culture and working environment. This organization culture can negatively affect physical and mental health and health behavior [9,10].

Table 4. Metabolic syndrome components and cardiovascular disease between day and shift workers

Variables	Category	Day Worker (N=3561)		Shift Worker (N=730)		All		Chi square	*p*
		N	%	N	%	N	%		
Hypertension	Normal	1612	53.2	336	53.7	1948	53.3	0.52	0.772
	Prehypertensive	855	28.2	174	27.8	1029	28.2		
	Hypertensive	561	18.5	116	18.5	677	18.5		
Diabetes	Normal	2334	77.1	508	81.2	2842	77.8	8.00	0.018
	IFG	566	18.7	97	15.5	663	18.1		
	Diabetes	128	4.2	21	3.4	149	4.1		
Hypercholesterolemia	No	2763	91.3	567	90.6	3330	91.1	0.68	0.408
	Yes	265	8.8	59	9.4	324	8.9		
Obesity	Underweight	89	2.9	24	3.8	113	3.1	4.41	0.221
	Normal	1225	40.5	242	38.7	1467	40.2		
	Overweight	692	22.9	129	20.6	821	22.5		
	Obese	1022	33.8	231	36.9	1253	34.3		
Central obesity	No	2802	78.7	578	79.2	3380	78.8	0.09	0.767
	Yes	759	21.3	152	20.8	911	21.2		
Metabolic syndrome	No	2845	79.9	589	80.7	3434	80	0.24	0.626
	Yes	716	20.1	141	19.3	857	20		

IFG = impaired fasting serum glucose

However, there were no significant differences regarding hypertension, hypercholesterolemia, obesity, central obesity, and metabolic syndrome between two different work groups. The prevalence of hypertension varied in types of work [28] and one study stated long working hours was associated with higher prevalence of hypertension [8]. Korean

day workers tend to have more chances to drink due to the organizational culture [10]. Considering that high-risk alcohol drinking increased the risk of hypertension [29], the influences of organizational culture on hypertension can be counterbalanced to the ones of shift work on hypertension. It might lead to similar prevalence of hypertension in both shift worker and day workers in this study, contrary to previous studies. Moreover, participants of this study were relatively young age in which cardiovascular disease markers do not obviously appear. Furthermore, 77% of office workers drink and only less than 30% of them do regular exercise in Korea, which shows even office workers do not have good health behavior [30]. Therefore, it is necessary to consider and examine various factors regarding the relationship between the shift work and the prevalence of hypertension. Also, it is possible that workers transferred from shift work to day work when they became sick even though it is uncertain that this was cross-sectional study. Accordingly, a longitudinal study is required that considers job and organizational characteristics as well as shift work in doing the future study regarding the influence of shift work on health status.

This study has several limitations. First, there is the lack of causality between shift work and health problems in this cross-sectional study. The assessment of shift work and occupation depended on the self-reported questionnaires without further structured interviews. There is limit to seize the relationship between the period of shift work and the prevalence of health problems because the survey used yes and no question for current shift work. This also cannot exclude the cases that shift workers transferred to day work after having a health problem. Second, all work except day work was considered as shift work in this study rather than being classified by types of work, hours of work, and other specific differences. Published evidence is suggestive but not conclusive for an adverse association between shift work and CVD risk factors due to heterogeneity of study exposures [5]. Different shift work may have different influences on health. Accordingly, types of shift work need to be identified. Third, in this study, it was not considered that organizational culture and sociocultural characteristics could affect the health of workers. So the result of this study was different from that of prior studies in other countries. Therefore, it is necessary to consider organizational culture and sociocultural characteristics in the future study.

4. Conclusions

This study is meaningful in analyzing whether shift work has an influence on CVD risk factors and health related life habits. Shift workers showed a higher prevalence of current smoking compared to day workers. Shift work should be considered during the development

of health promotion programs, and initiatives to promote smoking cessation in shift workers are needed. There were no significant differences in hypertension, obesity, or metabolic syndrome between day and shift workers. Further studies are necessary to determine why the effects of shift work on CVD risk factors differed from those reported previously. It is suggested that a longitudinal study be done to show the effect of shift work on CVD risk factors by clarifying the relationship between the period of shift work and health status in the future.

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