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A nationwide study reported that shift work is associated with higher suicidal ideation in male workers. The detrimental influence of shift work may be more pronounced in certain age groups based on the interference with social factors. Our results suggest that appropriate regular rotating shift work may be an important strategy for the prevention of suicide in working populations.

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## Association between shift work and suicidal ideation: data from the Korea National Health and Nutrition Examination Survey (2008–2016)

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**Objective** Studies on the relationship between shift work and suicidal ideation are scarce. This study aimed to investigate the impact of shift work on suicidal ideation using a nationwide representative sample from the Korean working population.

**Methods** The association between shift work and suicidal ideation was determined using data in 17 756 Korean workers over 19 years of age with fixed work schedules. These data were collected from the nationwide cross-sectional Korean National Health and Nutrition Examination Survey (2008–2016). The odds ratios (OR) and 95% confidence intervals (CI) for suicidal ideation were calculated by sex and age using multiple logistic regression models.

**Results** Approximately 14% of included participants were classified as shift workers. Among male workers, evening and night shift workers had a significantly increased risk of suicidal ideation compared to day workers after adjusting for demographics, lifestyle factors, comorbidities, number of work hours, and occupational type (OR 1.89, 95% CI 1.25–2.88 for evening-fixed workers and OR 1.38, 95% CI 1.03–1.86) for night-fixed workers]. Age-stratified analyses indicated that shift workers were more likely to report suicidal ideation than day workers in young and middle-aged groups.

**Conclusion** Evening and night shift work is associated with higher suicidal ideation among male workers.

**Key terms** depression; KNHANES; mental health; nationwide; sex difference; shift worker; stress; suicide.

We are living in an ever-bright era. Individuals who work non-standard (ie, non-day time) hours fill indispensable roles in modern society (1). Knutsson defined shift work “as an arrangement of working hours that uses teams (shifts) of workers, in order to extend the hours of operation of the work environment beyond that of the conventional office hours” (2). Currently, the term “shift work” includes regular evening or night schedules, rotating shift schedules, on-call or 24-hour shifts, and irregular shift schedules. Shift work is prevalent throughout the world, and approximately 20% of the workforce reports work schedules that include shift work.

Working at non-standard times, particularly during evening and night shifts, is associated with poor diet, lack of exercise, and sleep problems, resulting in increased workplace accidents (3) and a variety of negative health outcomes (4, 5). The shift work environment in general has also been linked to mental problems (6,

7). Although there is comparatively little research on the mental effects of shift work, several observational studies have reported that night shift work is associated with an increased risk of mental illnesses, including depression and anxiety (8, 9).

Suicide is a serious public concern worldwide, with close to 800 000 death every year (10). In the Republic of Korea, suicidal deaths have increased since 1985, and suicide is estimated to be the third leading cause of death among Korean males in 2028–2032 (11). As of 2016, the age-standardized rate of suicide in Korea was 25.8 per 100 000 people, which is the highest rate among Organisation for Economic Co-operation and Development (OECD) countries (average rate, 11.6 per 100 000) (12).

The work environment has been associated with suicide risk. Several psychosocial job stressors, including low control, high demands, low social support, precari-

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ous employment, and long working hours, have been suggested as risk factors for suicidal ideation (7, 13), including among Korean workers (14, 15). Although a few studies have examined the relationship between shift work and suicidal ideation (15–20), the findings have been inconsistent across occupations. In addition, these studies did not examine representative individuals from the Korean population. The aim of this study was to determine the relationship between shift work and suicidal ideation using a nationwide representative sample from Korea.

## Methods

### Study design and participants

We used data from the 2008–2016 Korea National Health and Nutrition Examination Survey (KNHANES), which was collected using a stratified, multistage, probability-sampling design. Briefly, some primary sampling units (PSU) were extracted from geographically defined PSU for the whole country. One PSU consisted of an average of 60 households, and 20 households were finally sampled from each PSU. In the selected households, all individuals over one year old were targeted. The KNHANES is a nationwide population-based survey conducted by the Korea Centers for Disease Control and Prevention. The survey had four components: the Health Interview Survey, the Health Behavior Survey, the Health Examination Survey, and the Nutrition Survey. Trained medical staff and interviewers performed the former three surveys on a single day at mobile examination centers. The health interview collects information via two methods: (i) information on lifestyle (smoking, alcohol, physical activity) and mental health are collected via self-administered questionnaire; and (ii) information on housing characteristics, medical conditions, and socioeconomic status, are obtained from a face-to-face interview. Detailed information on the design of the survey has been provided elsewhere (21). KNHANES includes a new sample of about 10 000 individuals annually, with response rate of 75–80%.

Participants >19 years who reported being employed with fixed work schedules were identified (N=25 521). Of these, those reporting chronic diseases that would affect the results, such as depression, stroke, myocardial infarction, or cancer, were excluded (N=1280, 5.0%). After additionally excluding participants with missing mental health data (N=6485, 25.4%), a total of 17 756 (69.6%) participants were included in the final analysis (figure 1). Differences in characteristics between finally included individuals and excluded individuals due to missing mental health data presented in supplementary

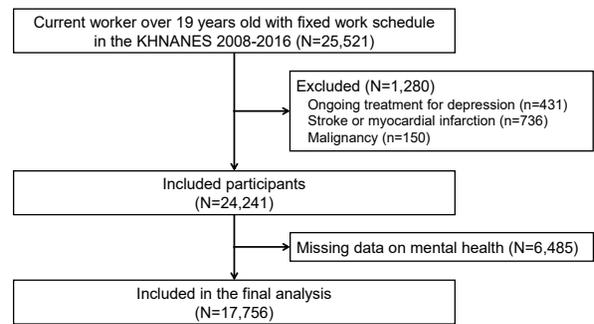


Figure 1. Flow chart of individuals recruited for the study.

table S1 ([www.sjweh.fi/show\\_abstract.php?abstract\\_id=3812](http://www.sjweh.fi/show_abstract.php?abstract_id=3812)). All participants provided written informed consent to participate in the study. The KNHANES study followed the guidelines put forth in the Declaration of Helsinki. The Institutional Review Board of Gachon University Gil Medical Center approved the present study (IRB number: GCIRB 2018-399).

### Data collection

Mental issues, including perceived stress, depressive mood, and suicidal ideation, were assessed through the self-reported responses to the questions “How much stress do you have in your daily life?”, “Have you ever felt sadness or despair continuously for more than two weeks during the past year?”, and “Have you ever thought about committing suicide within the last 12 months?”, respectively. For depressive mood and suicidal ideation, the participants answered with a “yes” or “no” response. Possible responses for the question about perceived stress were none, mild, moderate, and severe. Participants who answered moderate or severe were classified into the perceived stress group.

To determine whether the participant engaged in shift work, we used the question, “When do you work?”. Participants who answered mostly during day time (between 06:00 ~ 18:00 hours) were classified as day-fixed workers; between 14:00 ~ 24:00 hours as evening-fixed workers; and between 21:00 ~ 08:00 hours as night-fixed workers. We excluded those who answered regular day and night rotating shift, 24-hour rotating shift, split shift (working two shifts in one day), or irregular rotating shift, due to the small number of respondents in these categories. We also collected data regarding the number of work hours per week (15) and occupational types (manual and non-manual according to the degree of physical strain). The occupations in KNHANES were classified into ten categories based on the International Standard Classification of Occupations of Internal Labor Organization (22). The manual group consisted of skilled agricultural forestry and fishery

workers, craft and related trades workers, equipment, machine operating and assembling workers, and elementary workers, whereas the non-manual group consisted of managers, professionals and related workers, clerks, service workers and sales workers.

Information on demographics (age, sex, marital status, and household income), lifestyle factors (smoking history, alcohol consumption, and physical activity), and history of comorbidities (hypertension, type 2 diabetes, and arthritis) was obtained during the health interview. After the interview, height and weight were measured (all participants in light clothing and no shoes). Body mass index was calculated as weight in kilograms divided by the square of the height in meters.

Obesity was defined as a body mass index  $\geq 25$  kg/m<sup>2</sup> according to the Korean Society for the Study of Obesity (23). Other variables were categorized as follows: marital status was classified as married or unmarried, which included single and divorced/separated/widowed; economic status was classified as low or high according to the average value of family size-adjusted mean monthly income; smoking status was classified as non- or past-smoker or current smoker; alcohol consumption was classified as problem drinker ( $>7$  or 5 drinks in one sitting  $>2$  days per week for males or females, respectively) or other (24); physical activity was classified as

regular physical activity (moderate-intensity activity  $>5$  times per week or vigorous activity  $>3$  times per week) or other based on the International Physical Activity Questionnaire short-form scoring protocol.

### Statistical analysis

All analyses were performed using STATA SE 9.2 (Stata Corp, College Station, TX, USA), which incorporates sample weights and adjusts the analyses for the complex sample design of the survey. Survey sample weights were used to produce estimates that are representative of the non-institutionalized civilian Korean population.

Differences in characteristics by shift work type times were evaluated using either a Chi-squared test or one-way analysis of variance (ANOVA). Odds ratios (OR) and their 95% confidence intervals (CI) were calculated to determine the association between work times and mental distress. Multiple logistic regression analysis was performed both unadjusted and adjusting for age (continuous variable), marital status, economic status, lifestyle factors (ie, obesity, smoking, drinking, and physical activity), comorbidities (ie, hypertension, diabetes, and arthritis), and work hours (continuous variable).

All statistical tests were two-tailed, and results with  $P < 0.05$  were considered statistically significant.

**Table 1.** General characteristics of the study population by shift work type. [SD=standard deviation].

	Day (N=15 286)		Evening (N=1928)		Night (N=542)		P-value
	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)	
<b>Demographics</b>							
Age (years)		46.7 (14.8)		38.3 (14.8)		42.0 (15.1)	<0.001
<40	5647 (36.9)		1062 (55.1)		255 (47.1)		<0.001
40–59	6416 (42.0)		706 (36.6)		214 (39.5)		
$\geq 60$	3228 (21.1)		160 (8.3)		73 (13.5)		
Sex (female)	7488 (49.0)		1189 (61.7)		199 (36.7)		<0.001
<b>Marital status</b>							
Married	11 266 (89.6)		1003 (87.5)		317 (83.4)		<0.001
Unmarried <sup>a</sup>	1310 (10.4)		144 (12.6)		63 (16.6)		
<b>Household income</b>							
High	9290 (61.2)		1199 (63.0)		306 (57.1)		0.043
Low	5881 (38.8)		705 (37.0)		230 (42.9)		
<b>Lifestyle factors</b>							
Obese	4952 (32.5)		517 (27.0)		189 (34.9)		<0.001
Current smoker	3345 (21.9)		413 (21.4)		214 (39.5)		<0.001
Problem drinker	821 (5.4)		113 (5.9)		48 (8.9)		<0.001
Regular physical activity	2484 (19.8)		323 (21.0)		124 (26.5)		0.001
<b>Common comorbidities</b>							
Hypertension	2492 (16.3)		165 (8.6)		84 (15.5)		<0.001
Diabetes	911 (6.0)		56 (2.9)		23 (4.2)		<0.001
Arthritis	1299 (8.5)		108 (5.6)		31 (5.7)		<0.001
<b>Work hours per week</b>		42.2 (23.6)		36.8 (39.3)		45.7 (21.2)	<0.001
<b>Occupational type<sup>b</sup></b>							
Non-manual	7731 (57.8)		1241 (79.3)		239 (50.9)		<0.001
Manual	5641 (42.2)		325 (20.8)		231 (49.2)		
<b>Mental issues</b>							
Perceived stress	4182 (27.4)		574 (29.8)		166 (30.6)		0.026
Depressive mood	1660 (10.9)		249 (12.9)		70 (12.9)		0.011
Suicidal ideation	1377 (9.0)		213 (11.1)		64 (11.8)		0.002

<sup>a</sup> Includes single, separated, divorced, and widowed.

<sup>b</sup> Recategorized according to physical strain from the Korean Standard Classification of Occupation.

## Results

Approximately 14% of all workers included in the analysis were classified as shift workers (11% evening-fixed and 3% night-fixed). Table 1 reports the characteristics according to shift work type. Among three groups, day-fixed workers were more elderly and married, had more comorbidities, and were less likely to be problem drinker or regular exerciser. In addition, day-fixed workers report less mental distress ( $P<0.05$  for all three mental issues). The prevalence of suicidal ideation was 9.0% in day-fixed, 11.1% in evening-fixed, and 11.8% in night-fixed workers.

Table 2 reports the OR and 95% CI for the existence of mental issues by sex. Fully adjusted OR ( $OR_{adj}$ ) for suicidal ideation were 1.88 (95% CI 1.27–2.80) for evening-fixed male workers and 1.38 (95% CI 1.03–1.83) for night-fixed male workers. Perceived stress and depressive mood were not significantly different across shift work types in male workers, and no mental issues were significantly different across shift work types in female workers. Figure 2 reports the impact of shift work on suicidal ideation in male workers by age. Compared with day-fixed male workers, shift workers had significantly higher suicidal ideation in young and middle-aged group: young night-fixed male workers ( $OR_{adj}$  2.79;  $P=0.004$ ) and middle-aged evening fixed male workers ( $OR_{adj}$  1.97,  $P=0.015$ ) had the highest one.

## Discussion

It is critical to identify individuals at high risk for suicide to provide them with appropriate mental health services. Several intervention studies (25, 26) have reported that changing adverse working conditions is beneficial for the mental health of workers. In this study, we found that shift work was independently associated with suicidal ideation in Korean male workers. Our

results suggest that appropriate regular rotating shift work may be an important strategy for the prevention of suicide in working populations. To date, few studies (15, 17) have used nationwide data to explore the association between shift work and suicidal ideation. The results of our nationwide study are likely to be generalizable to Korean workers.

The pathways through which shift work results in higher suicidality is likely to be related to depression. It is well known that shift work is associated with an increased risk of depression (27). Although depressive mood was not significantly different across shift work types in our study, depression has multifactorial causes and there is likely to be an association when adjusting for the appropriate covariates (supplementary table S2, [www.sjweh.fi/show\\_abstract.php?abstract\\_id=3812](http://www.sjweh.fi/show_abstract.php?abstract_id=3812)). Shift work also disrupts circadian rhythms, which may contribute to the development of stress-related mental problems in vulnerable individuals (28, 29). Furthermore, interrupted endogenous melatonin secretion, which occurs in night shift workers, can cause depression (30, 31) and possibly suicide. A psychosocial explanation for an increased suicide risk among shift workers is also plausible: given that most activities take place during the day, shift work is likely to interfere with social obligations and/or family life (32).

Several studies have been conducted to identify factors associated with suicidality in the work environment (7), but few studies (15, 17) have explored the association between shift work and suicidal ideation using nationwide data. In a questionnaire survey among 3233 workers, Takusari et al (17) reported a crude association with suicidal ideation in male shift workers (OR 2.46, 95% CI 1.50–4.04), but this association did not remain significant in the multivariate analysis, which is inconsistent with our findings. Our study limited participants only to those who reported fixed work schedule to more explicitly investigate the impact of shift work. Another study using data from the Korean Community Health Survey (KCHS) indicated that shift work was a predictor of suicidal ideation in female workers (OR 1.45.

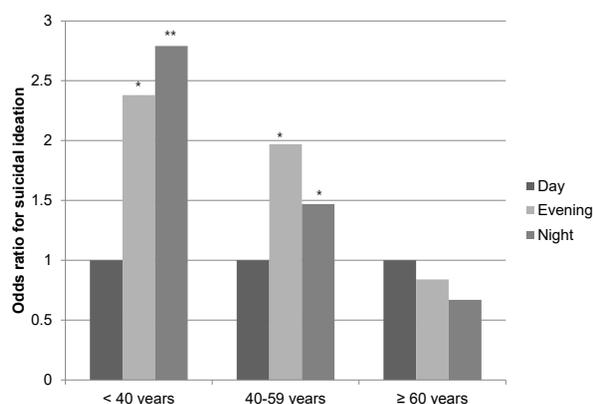
**Table 2.** Odds ratios and 95% confidence intervals for mental health issues by shift work type. [OR=odds ratio; CI=confidence interval]

	Unadjusted N in model	Adjusted N in model	Perceived stress		Depressive mood		Suicidal ideation	
			OR (95% CI)	$OR_{adj}$ (95% CI) <sup>a</sup>	OR (95% CI)	$OR_{adj}$ (95% CI) <sup>a</sup>	OR (95% CI)	$OR_{adj}$ (95% CI) <sup>a</sup>
<b>Male worker</b>								
Day			1	1	1	1	1	1
Evening	8537	5180	1.14 (0.96–1.35)	0.96 (0.72–1.28)	1.19 (0.91–1.55)	1.20 (0.76–1.92)	1.35 (1.03–1.77) <sup>b</sup>	1.89 (1.25–2.88) <sup>c</sup>
Night	8141	5013	1.01 (0.89–1.14)	1.01 (0.80–1.28)	1.05 (0.86–1.27)	0.93 (0.62–1.37)	1.16 (0.95–1.41)	1.38 (1.03–1.86) <sup>b</sup>
<b>Female worker</b>								
Day			1	1	1	1	1	1
Evening	8677	4626	1.07 (0.94–1.22)	0.78 (0.62–0.98) <sup>b</sup>	1.10 (0.93–1.31)	1.08 (0.82–1.43)	1.09 (0.91–1.32)	0.98 (0.72–1.34)
Night	7687	4238	1.23 (1.07–1.43) <sup>c</sup>	1.19 (0.95–1.50)	1.26 (1.06–1.50) <sup>b</sup>	1.02 (0.77–1.37)	1.27 (1.06–1.53) <sup>b</sup>	1.05 (0.77–1.41)

<sup>a</sup> Adjusted for age (continuous), marital status, economic status, lifestyle factors (obesity, smoking, alcohol, and physical activity), comorbidities (hypertension, diabetes, and arthritis), work hours (continuous), and occupational type.

<sup>b</sup>  $P<0.05$ ;

<sup>c</sup>  $P<0.01$ .



**Figure 2.** Association between shift work and suicidal ideation among male workers by age (\* $P < 0.05$ , \*\* $P < 0.01$ ).

95% CI, 1.23–1.70), however that was true only in the employee group (15). Because the study was designed for investigating the impact of employment status and working time, direct comparison with our results might be difficult. In addition, the KCHS aims to produce comparable health statistics across the regions, not to build a representative data like the KNHANES.

In the current study, shift work was associated with suicidal ideation in male but not female workers. Suicidal ideation generally occurs more frequently among females (6.7% for male and 11.9% for female in our sample), but most studies have found that the impact of job stressors on suicidal deaths is higher in males (33, 34). Males are vulnerable to problems related to their inability to accomplish the “breadwinner” role effectively; this is a problem particularly in Asian cultures. A previous study has reported that male shift workers also suppress their external social desire for the livelihoods of their family (35), which is consistent with the findings of our age-stratified analysis. The detrimental influence of shift work may be more pronounced in certain age groups based on the interference of work time with social factors. For example, among young adults, night time is critical for maintaining social networks and human resources. Similarly, among middle-aged adults, the evening is reserved for quality family time. Additional studies and qualitative investigations are needed to clarify and confirm these findings.

Our study had some limitations. First, the cross-sectional design limits our ability to attribute causality in a particular direction. This is also true on the covariates, for example, it is reasonable to interpret that shift work was more amenable to individuals who were more physically active and had less comorbidity, not vice versa. Additionally, their years in workplace at the survey or switching jobs near the survey could impact on the temporality. Future longitudinal research with sequential

evaluation of mental distress is warranted. Second, shift workers included in this study may be healthier than the general working population. Workers with severe health issues, including mental distress, may not participate in the KNHANES (or may have already died), thus we might have underestimated the true risks of shift work. Another selection bias should also be acknowledged (supplementary table S1) because approximately 25% of participants were excluded due to missing data on mental issues. Third, we were unable to assess several other factors within the workplace that may contribute to suicide ideation, such as excessive workload, insufficient job control, interpersonal conflict, lack of support, lack of job security, and unsatisfactory compensation (36–38). Furthermore, given that small studies potentially disturb the extensive adjusted analyses (eg, too few night-fixed workers in our study), a sufficiently large sample size is also necessary to confirm our results. Finally, some sensitive subjects (eg, mental issues and drinking habits) were assessed by a self-reported simple question, raising the possibility for misclassification or information bias. However, those simple methods have been used as a reasonable alternative to more lengthy questionnaires in the large-scale survey.

Despite these limitations, our study extends the findings from previous studies by examining the relationship between shift work and suicidal ideation. In this 9-year nationally representative study, we found that shift work was independently associated with suicidal ideation among male shift workers in Korea. The ability to address adverse work environments has the potential to mitigate or prevent mental health problems among workers (39). We would also recommend that future interventional studies are conducted to confirm our findings.

#### Conflict of interest

The authors declare no conflicts of interest.

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