Comparing risk of depression between day and night/shift workers using the PHQ-9: a study utilizing the 2014, 2016, and 2018 Korea National Health and Nutrition Examination Survey data

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ABSTRACT

Background: In today's work scenario, the number of shift workers, including those in night shifts, is increasing. Shift work can adversely affect workers' health in the long run, but studies on the relationship between shift work and depression have shown inconsistent results. This study aimed to determine whether the number of night/shift workers at risk of depression, as predicted by the Patient Health Questionnaire-9 (PHQ-9), is higher than that of day workers.

Methods: This study was conducted based on data from the 6th and 7th Korea National Health and Nutrition Examination Survey, 2014, 2016, and 2018. Work schedules were classified into 2 types: day work and night/shift work. This study used the PHQ-9, a self-reported depression screening test, to identify workers at risk of depression. Statistical analysis was performed using SPSS 26.0, and descriptive statistics, χ² test, and logistic regression analysis were employed.

Results: After adjusting for age, educational level, working hours per week, and income, men engaging in night/shift work were at a higher risk of depression (odds ratio [OR]: 1.407, 95% confidence interval [CI]: 0.937–2.113). The same was confirmed for women (OR: 1.564, 95% CI: 1.176–2.081).

Conclusions: Our results showed that the OR for those engaged in night/shift work with a PHQ-9 score of 10 or more increased. Considering the large volume of psychiatric history and symptoms in Korea, additional research is needed. Additionally, further discussion on ways to provide realistic help to night/shift workers is warranted.

Keywords: Day work; Shift work; Night work; PHQ-9; Depression

BACKGROUND

In today's work scenario, the requirement for shift workers, including night shifts is increasing. Currently, about 15%–20% of workers in Europe and the United States are engaged in shift work, including night work. According to the Work Environment Survey...
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Competing interests
The authors declare that they have no competing interest.

Author contributions
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conducted by the Korea Occupational Safety and Health Agency, the proportion of shift workers among domestic workers was 7.1%, 7.2%, and 9.7% in 2014, 2015, and 2017, respectively, showing a gradual increase.2

Depression is highly associated with suicide, and it has been found that many of those who died by suicide were suffering from depression at the time of death.3 According to the statistics on causes of death in 2019 compiled by the National Statistical Office in Korea, suicide ranked number one among those in their teens, 20s, and 30s, and number 2 among those in their 40s and 50s.4 When comparing the age-standardized suicide rate, it can be seen that Korea has the highest suicide rate at 24.6, compared with the Organisation for Economic Co-operation and Development average of 11.3.

Shift work can adversely affect workers' health in the long run. It is known to significantly increase the incidence of gastrointestinal diseases and symptoms in comparison to consistent daytime work.5 In addition to breast cancer and cardiovascular diseases,6,7 recent studies have reported that shift work can increase the incidence of chronic inflammatory diseases such as asthma.8

As such, studies are being conducted on the physical and mental effects of night and shift (hereafter “night/shift”) work in various occupations; however, research on the effects on mental health is insufficient compared with that on the effects on physical health,9 and studies on the relationship between shift work and depression have shown inconsistent results.

For example, a population-based study of 277,168 workers in the UK biobank showed that shift workers were more likely to be obese, depressed, to report disturbed sleep, and to have neurotic traits.10 A number of cross-sectional studies of workers in specific occupations, such as nurses, have suggested a relationship between night and shift work and depressive symptoms.11,12 However, a 10-year observational cohort study showed contrary evidence, wherein being engaged in present or previous night work was not associated with sickness absence due to mental health problems.13 Some observational studies reported that there was no significant association between night/shift work and depression.14,15

There is also a meta-analysis on the subject, but in this analysis, the authors stated that the study included a small number of observational studies to draw definite conclusions because of a paucity of data. Therefore, further case-control studies and prospective cohort studies are warranted.16

The proportion of night/shift workers among domestic workers is constantly rising, and with studies on the relationship between shift work and depression showing inconsistent results, the impact of work type on workers' mental health can be difficult to grasp. With the importance given to the prevention and treatment of depression in Korea, clearly understanding the relationship between night/shift work and depression will likely become even more crucial in the future.

In the present study, using the Korea National Health and Nutrition Examination Survey (KNHANES), we aimed to determine whether the number of night/shift workers at risk of depression, as predicted by the Patient Health Questionnaire-9 (PHQ-9), is higher than that of day workers.
METHODS

Data sources & study population
This study was conducted based on data from the National Health and Nutrition Survey, which examined 10,851 adults aged 20 years and above in the 6th and 7th (2014, 2016, and 2018) KNHANES. Of the total 22,328, 819 people diagnosed with depression by a doctor, and 4,720 aged under 20 were excluded, as were the 5,938 people who checked “Not applicable” or did not respond to the question (Fig. 1).

Exposure assessment
Shift work was defined by the KNHANES as a work schedule outside usual working hours (6 a.m.–6 p.m.), and night work as working through sleeping hours (9 p.m.–8 a.m.). Other working schedules such as evening work (2 p.m. to 12 midnight), 24-hour shift work, and irregular shift work were included as night/shift work.

General characteristics included gender and age (< 30, 30–39, 40–49, 50–59, and ≥ 60 years), educational level (below elementary school, middle school graduate, high school graduate, and university graduate or higher), alcohol consumption (less than once a month, more than twice a month), and smoking (no smoking experience, non-smoker, smoker). Occupational characteristics included work-related moderate-intensity physical activity, weekly working hours (less than 52, more than 52), and quartile of personal income.

Outcome assessment
In our study, based on characteristics related to mental health, a risk of depression of less than 10 points indicated low-risk, and 10 points or more indicated high-risk. This was based on the Korean version of the PHQ-9, where the following stress perception levels were used: 1) I feel too stressed; 2) I feel stressed quite a bit; 3) I feel stressed slightly; and 4) I hardly feel stressed. Depression level was categorized as high (1 and 2) or low (3 and 4), and history of counseling for mental problems within a year were included.

The PHQ-9 was developed by Spitzer et al. to evaluate depression in primary healthcare centers, and its modified Korean version has been used as a depression screening tool in clinical practice. Although the PHQ-9 is not a tool for diagnosing major depressive disorder,
various studies have shown that those with a score of 10 or more can be considered to be at high-risk of major depressive disorder.\textsuperscript{17}

**Statistical analysis**
Statistical analysis was performed using SPSS 26.0 (IBM Inc., Armonk, NY, USA), and descriptive statistics, $\chi^2$ test, and logistic regression analysis were used as statistical methods. The significance level was set at $p < 0.05$. First, the general characteristics of day work and night/shift work were compared using a $\chi^2$ test. After that, the study sample was divided based on gender (male and female), and a $\chi^2$ test was conducted to assess the degree of risk of depression and stress perception.

Finally, through logistic regression analysis, the odds ratio (OR) for high-risk of depression and high stress perception level in night/shift work compared with day work was confirmed.

**RESULTS**

Table 1 compares the general characteristics of the day and night/shift work groups using a $\chi^2$ test. In terms of gender, there were no significant differences between the 2 groups. In the day work group, the proportion of those aged 60 or above was high, while in the night/shift work group, the proportion of those aged under 30 was high. In terms of education, the number of middle school and elementary school graduates was higher in the day work group than in the other groups, and there was no significant difference between the 2 groups with respect to alcohol consumption, smoking, manual labor, and personal income quartile. For the night/shift work group, weekly working hours exceeded 52 hours more often.

Risk of depression based on the PHQ-9 was found to be higher in the night/shift work group. However, there was no significant difference in the stress perception level and counseling for mental problems within one year between the 2 groups.

Table 2 compares the proportion of men and women at risk of depression and the degree of stress perception according to day and night shift work. A PHQ-9 score of 10 or higher was more common in the night/shift work group than in the day work group for both men and women. With respect to perceived stress, there was no difference between the genders irrespective of their work type (i.e., day work or night/shift work).

Table 3 shows the ORs for risk of depression and high stress perception level for night/shift work compared with day work. After adjusting for age, educational level, working hours per week, and income, men engaging in night/shift work were at a significantly higher risk of depression (OR: 1.407, 95% confidence interval [CI]: 0.937–2.113). The same was confirmed for women (OR: 1.564, 95% CI: 1.176–2.081). Stress perception level, on the other hand, was not found to be high for both men (OR: 0.932, 95% CI: 0.785–1.107) and women (OR: 0.947, 95% CI: 0.806–1.113) in the night/shift work group. This reveals that even though a large number of night/shift workers are at risk of depression, stress perception, which can also be interpreted by self-identification of depression, is low.
DISCUSSION

Through this study, we investigated the effect of night/shift work on workers’ PHQ-9 scores, and the determination of the OR for risk of depression among workers.

Table 1. General characteristics of day and night/shift work groups (n = 10,851)

| Characteristics                  | Day work     | Night/Shift work | p value* |
|----------------------------------|--------------|------------------|----------|
| Sex                              |              |                  |          |
| Male                             | 4,667 (51.5) | 881 (49.3)       | 0.096    |
| Female                           | 4,398 (48.5) | 905 (50.7)       |          |
| Age                              |              |                  | < 0.001  |
| < 30                             | 980 (10.8)   | 405 (22.7)       |          |
| 30–39                            | 1,791 (19.8) | 306 (17.2)       |          |
| 40–49                            | 2,064 (22.8) | 357 (20.0)       |          |
| 50–59                            | 2,005 (22.2) | 379 (21.3)       |          |
| ≥ 60                             | 2,193 (24.3) | 336 (18.8)       |          |
| Education                        |              |                  | < 0.001  |
| ≤ Elementary school              | 1,418 (15.7) | 194 (10.9)       |          |
| Middle school                    | 900 (10.0)   | 148 (8.3)        |          |
| High school                      | 2,880 (31.9) | 795 (44.6)       |          |
| ≥ College                        | 3,832 (42.4) | 646 (36.2)       |          |
| Alcohol consumption              |              |                  | 0.683    |
| ≤ Once a month                   | 4,402 (48.7) | 858 (48.2)       |          |
| ≥ Twice a month                  | 4,631 (51.3) | 922 (51.8)       |          |
| Smoking                          |              |                  | 0.059    |
| Never-smoker or ex-smoker        | 7,013 (77.7) | 1,347 (75.6)     |          |
| Current smoker                   | 2,015 (22.3) | 434 (24.4)       |          |
| Occupation                       |              |                  | 0.519    |
| Non-physical                     | 8,146 (89.9) | 1,597 (89.4)     |          |
| Physical                         | 913 (10.1)   | 189 (10.6)       |          |
| Weekly working hours             |              |                  | < 0.001  |
| ≤ 52 hours                       | 7,230 (79.8) | 1,358 (76.0)     |          |
| > 52 hours                       | 1,834 (20.2) | 428 (24.0)       |          |
| Personal income quartile         |              |                  | 0.054    |
| Low                              | 1,981 (21.9) | 397 (22.2)       |          |
| Middle low                       | 2,350 (26.0) | 496 (27.8)       |          |
| Middle high                      | 2,349 (26.0) | 479 (26.8)       |          |
| High                             | 2,366 (26.2) | 413 (23.1)       |          |
| Risk group for depression        |              |                  | < 0.001  |
| Low risk group                   | 8,708 (96.4) | 1,682 (94.3)     |          |
| High risk group                  | 325 (3.6)    | 101 (5.7)        |          |
| Stress perception level          |              |                  | 0.505    |
| Low                              | 6,670 (73.9) | 1,302 (73.1)     |          |
| High                             | 2,360 (26.1) | 479 (26.9)       |          |
| Counseling for mental problems within one year |          |                  | 0.862    |
| No                               | 6,358 (98.5) | 1,260 (98.6)     |          |
| Yes                              | 95 (1.5)     | 18 (1.4)         |          |

*p* Calculated by χ² test.

Table 2. The proportion of men and women at risk of depression and the degree of stress perception according to day and night/shift work

| Variables                                      | Depression risk | Stress perception | p value* |
|------------------------------------------------|-----------------|-------------------|----------|
|                                                 | Low risk        | High risk         | Low      | High   |
| Male                                           | 0.031           | 0.57              |          |
| Day work                                       | 4,545 (97.6)    | 111 (2.4)         | 3,525    | 1,123  |
| Night/Shift work                               | 846 (96.4)      | 32 (3.6)          | 658 (74.9)| 220 (25.1)|
| Female                                         | 0.001           | 0.783             |          |
| Day work                                       | 4,163 (95.1)    | 214 (4.9)         | 3,145    | 1,237  |
| Night/Shift work                               | 836 (92.4)      | 69 (7.6)          | 644 (71.3)| 259 (28.7)|

*p* Calculated by χ² test.
Our results showed that the OR for those engaged in night/shift work with a PHQ-9 score of 10 or more increased. While most previous studies conducted on this topic so far have shown that night/shift work increases the likelihood of depression, there are cases that do not show significant results. A 10-year observational cohort study showed that being engaged in present or previous night work was not associated with sickness absence due to mental health problems. In a 2013 cross-sectional study of 5,400 nurses in Norway, no association was observed between night work and depression. The present study supports the case that night/shift work is likely to cause depression in workers.

Biological mechanisms that show that night/shift work may be associated with depression include the following: first, environmental stress, such as night/shift work, decreases the methylation of the promoter of the serotonin transporter gene (SLC6A4), reducing the amount of extracellular serotonin in the synaptic gap, which can lead to mental disorders such as depression; and disruptions in glucocorticoid oscillations consistent with the biological clock every 24 hours may cause a signaling problem between neurons along with a decrease in synapses, leading to depression. Our study shows similar results to support those of existing studies—that shift work can cause depression—and it is meaningful in that it shows the reproducibility of similar risks in Korean workers.

The limitations of the present study are as follows. First, the cross-sectional design of the study precludes any causal inferences. In addition, the shift workers included in this study might represent a relatively healthy part of the working population, and the participants in this study may have already adapted to their work schedule before the start of the survey.

The greatest strength of this study is that it was population-based; it uses large-scale data from the KNHANES, so it can be said that it provides meaningful results even though it is a cross-sectional study. Most cross-sectional studies that show the relationship between night/shift work and depression are based on certain occupational groups such as nurses, and those groups may experience depression due to the intensity of work and the stressful nature of the work itself.

In addition, this study used the PHQ-9, which has high reliability as a depression screening tool for those at high-risk of depression. Considering the current psychiatric approach to depression in Korea and the fact that the diagnosis rate is remarkably low, the identification of those at high-risk of depression through the PHQ-9 could play an important role in the screening of night/shift workers.

### Table 3. OR and 95% CIs for high risk group and stress perception

| Variables | High risk group OR (95% CI) | Stress perception OR (95% CI) |
|-----------|-----------------------------|------------------------------|
| Model 1a  |                             |                              |
| Male      |                             |                              |
| Day work  | Reference                   | Night/Shift work Reference   |
| Night/Shift work | 1.549 (1.038–2.311) | Night/Shift work Reference  |
| Female    |                             |                              |
| Day work  | Reference                   | Night/Shift work Reference   |
| Night/Shift work | 1.606 (1.212–2.127) | Night/Shift work Reference  |
| Model 2b  |                             |                              |
| Male      |                             |                              |
| Day work  | Reference                   | Night/Shift work Reference   |
| Night/Shift work | 1.407 (0.937–2.113) | Night/Shift work Reference  |
| Female    |                             |                              |
| Day work  | Reference                   | Night/Shift work Reference   |
| Night/Shift work | 1.564 (1.176–2.081) | Night/Shift work Reference  |

Calculated using multiple logistic regression analysis.

OR: odds ratio, CI: confidence interval.

aCrude odds ratio; bAdjusted by age, education, working hour, income.
This study also shows that self-identification of depressive symptoms among night/shift workers in Korea is low. It is known that less self-identification of depressive symptoms can lead to lower requests for professional help for treatment.\textsuperscript{23,24} This could also explain why there was no significant difference in counseling for mental problems within one year between the 2 groups. Considering the high suicide rate in Korea, finding this kind of “missed” depression could help reduce the overall suicide rates. However, this result should be interpreted with some caution, as workers with high stress perception are more prone to earlier retirement of the work, thus leading to a “healthy worker survivor effect.” Therefore, additional research on when respondents enter into day and night/shift work is needed in the future.

The results of this study can be summarized as follows: Existing studies show that night/shift work increases the likelihood of depression, and there are theories that can explain this through biological mechanisms. However, as some studies show different results, further research is needed on the relationship between night/shift work and depression. In our study, the number of night/shift workers at risk of depression was significantly higher, with a PHQ-9 score of 10 or more, than that of day workers.

Furthermore, it is also necessary to pay attention to the additional information obtained during the research—that night/shift work did not affect the stress perception level and did not affect depression-related counseling within one year. This could mean that self-identification of depressive symptoms among night/shift workers in Korea is low, and thus led to lower requests for professional help for treatment. Considering the current volume of psychiatric history and symptoms in Korea, further discussion on ways to provide realistic help to night/shift workers is needed. For example, providing regular screening tests for depression among night/shift workers in Korea could help to provide appropriate professional help, thus leading to lower depression and suicide rates among night/shift workers.

**CONCLUSIONS**

This study investigated the association between night/shift work and depression. Despite its limitations, this study provides evidence for the association between night/shift work and depression. Considering the trend that the number of night/shift workers and suicide deaths continues to increase in Korea, further discussions and realistic help for domestic workers will be needed.

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