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Original Article

The mediating effects of working hours, sleep duration, and depressive mood on the association between shift work and the risk of suicidal ideation in Korean workers

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ABSTRACT

Objectives: This study aimed to investigate the mediating effects of working hours, sleep duration, and depressive mood on the association between shift work and the risk of suicidal ideation in Korean workers.

Methods: Data from 33,047 workers were obtained from the nationwide cross-sectional Korea National Health and Nutrition Examination Surveys conducted in 2007–2018. Healthy workers without depressive disorders and chronic medical illnesses were included in the current study. Shift work patterns, sleep duration, working hours, depressive mood, and suicidal ideation were assessed using self-reported questionnaires. Multivariate logistic regressions were used to examine the association between shift work and the risk of suicidal ideation. Additionally, mediating studies were conducted to identify the roles of working hours and sleep durations on the association.

Results: Compared with daytime workers, shift workers had 1.33 times greater risk of suicidal ideation (OR = 1.33, 95% CI = 1.17–1.52, $p < 0.001$). Specifically, among shift work patterns, fixed-night shift, 24-h rotating shift and irregular rotating shift were associated with the risk of suicidal ideation when compared with daytime workers (irregular rotating shift: OR = 1.92, 95% CI = 1.29–2.86, $p = 0.001$; fixed-night shift: OR = 1.75, 95% CI = 1.32–2.31, $p < 0.001$; 24-h rotating shift: OR = 1.58, 95% CI = 1.06–2.36, $p = 0.024$). In the mediating study, working hours, sleep duration and depressive mood significantly mediated the relationship between shift work and suicidal ideation (direct effect: $\beta = 0.019$, $p = 0.001$; indirect effect: $\beta = 0.004$, $p = 0.031$; total effect: $\beta = 0.023$, $p < 0.001$).

Conclusion: This study revealed that shift workers had a greater risk of suicidal ideation. The patterns significantly associated with suicidal ideation were irregular rotating, fixed-night, and 24-h rotating shifts. The pathway analysis revealed serial mediating effects of working hours, sleep duration, and depressive mood on the association between shift work and suicidal ideation.

1. Introduction

With the advance of the industrialized world, a 24/7 operation system is necessary for public health services, manufacturing, and transportation. As a result, approximately 15–30% of working adults are engaged in non-standard shifts outside 7:00 AM to 6:00 PM [1]. Shift work includes night shifts; therefore, the sleep–wake cycle is disrupted, which leads to circadian misalignment [2]. The adverse consequences of shift work have been reported in a growing body of literature. Shift workers are more likely to suffer from insomnia or sleepiness because they should sleep during the day under high alerting signals and low melatonin secretion while night work is expected to occur when circadian alerting signals are lowest [3]. Both insomnia and sleepiness are risk factors of depression [4] and attention difficulties during work cause low performance, which leads to low self-esteem and sick leave [5,6].

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Indeed, a recent meta-analyses has reported that shift workers have 1.33 times higher risk of the development of depression [3]. Additionally, hypofrontality, which derives from a desynchronization between the alerting system and night work, results in impaired emotional regulation, lack of coping skills, and heightened impulsivity. This can increase vulnerability to suicide [7,8].

Under circadian misalignment, working hours should be considered as risk factors of various mental illness because long working hours disrupt sufficient sleep and social activity in a shift work system. Previous studies have revealed that long working hours are a risk factor of depression and suicide [9,10]. Shift workers are affiliated with sleep debt and social isolation [7]; therefore, when adequate sleep and leisure time are more disrupted due to long working hours, increased work stress cannot be relieved through restorative sleep and social activity. Taken together, this means that shift workers with long working hours may be more vulnerable to depression and suicide.

There were two goals in this study. First, we aimed to investigate the association between various shift work and suicidal ideation. Second, we examined our serial mediating model to assess whether the association between shift work and suicidal ideation was mediated by working hours, sleep duration, and depressive symptoms.

2. Participants and methods

2.1. Participants

This study used data from the Korean National Health and Nutrition Examination Survey (KNHANES). This is a nationally representative, cross-sectional survey that has been assessing the health and nutritional status of Koreans annually by the Korea Centers for Disease Control and Prevention (KCDC) since 1998 [11]. The sampling plan follows a complex, stratified, multi-stage cluster sampling design among non-institutionalized civilians in South Korea. The KNHANES consists of health interviews, health examinations, and dietary surveys. During the health interview, self-reported questionnaires, including age, sex, marital status, education and economic activities, alcohol consumption, smoking status, sleep, mental health status, occupational characteristics, and personal medical history, are collected during the health interview. Anthropometric and blood biochemical data are measured during the health examination [11]. All participants provide written informed consent and the survey protocol was approved by the KCDC Institutional Review Board (IRB Nos. 2007-02CON-04-P, 2008-04EXP-01-C, 2009-01CON-03-2C, 2010-02CON-21-C, 2011-02CON-06-C, 2012-01EXP-01-2C, 2013-07OCN-03-4C, 2013-12EXP-03-5C, 2015-01-02-6C, 2018-01-03-P-A).

2.2. Selection of "healthy" workers

Workers aged over 19 years who underwent KNHANES between January 1, 2007, and December 31, 2018, were included in this study. We excluded workers who had received antidepressant treatments (N = 285). Also we excluded those with any history of physical illnesses (brain hemorrhage/cerebral infarction, myocardial infarction/angina, chronic renal failure, liver cirrhosis, and cancer; N = 767) to reduce reversal causality. Thus, the final sample comprised of 33,047 workers (Fig. 1).

2.3. Assessment of shift work patterns

Daytime workers are defined as employees who have most of the shift occurs during the day (from about 06:00 to 18:00). Shift workers are regarded as those who work beyond the conventional office hours (from about 18:00 to 06:00). If a work schedule overlapped two categories, participants chose only one work pattern depending on where most of their working hours belong. Regarding fixed and rotating shift patterns, a fixed-shift schedule has a crew that always works the same shift. With a rotating schedule or shift pattern, employees change their working hours over a given period including morning, evening, and night shifts. Based on this understanding, shift workers are categorized according to shift time and rotating patterns as follows: fixed-evening shift (about 14:00–24:00), fixed-night shift (about 21:00–08:00), regular day and night rotating shift, 24-h rotating shift, split shift (working 2 shifts in 1 day), and irregular rotating shift.

2.4. Assessment of sleep duration, working hours, depressive mood, and suicidal ideation

Sleep durations and working hours were measured using self-reported questions as follows: "How many hours do you usually sleep a day?" and "How many hours do you usually work per week, including overtime?" Depressive mood was assessed using a self-reported question regarding whether they had felt depressed enough to interfere with daily life during the two weeks: "Over the last year, have you ever felt sad and hopeless enough to interfere with daily life nearly every day during the two weeks?" To assess suicidal ideation, participants were asked a yes-or-no question regarding whether they had ever seriously thought of committing suicide in the past year: "Over the last year, have you ever felt that you would be better off dead?"

2.5. Other variables

Age, sex, marital status, final degree, income status, alcohol consumption frequency, and smoking status were collected using the self-reported questionnaires. Data regarding occupation and employment status were also collected. According to the International Standard Classification of Occupations of Internal Labor Organization [12], occupations were categorized into ten groups: 'managers,' 'professionals,' 'office workers,' 'service workers,' 'sales workers,' 'agricultural, forestry and fishery workers,' 'craft and related trades workers,' 'plant and machine operators and assemblers,' 'elementary occupations,' 'armed forces,' and 'others.' Employment status was divided into four groups: 'wage workers', 'owner-operators and employers', 'unpaid family worker', and 'others'.

2.6. Statistical analysis

Descriptive statistics were used to show sociodemographic and occupational characteristics regarding suicidal ideation. The t-test and Chi-square test were conducted to examine differences between daytime and shift workers. We used logistic regression models to determine whether various shift work patterns were associated with the risk of suicidal ideation compared with daytime work. All regression models were adjusted for age, sex, marital status, education, income, alcohol consumption frequency, smoking status, sleep duration, depressive symptoms, occupation, employment status, and working hours. A two-tailed p-value of <0.05 was considered significant. Path analyses were conducted to test the mediating effect of working hours, sleep duration, and depressive symptoms on the association between shift work and the risk of suicidal ideation. The Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Tucker–Lewis Index (TLI) were used to assess the fitness of the model. RMSEA values of ≤ 0.05 indicated a close fit; the RMSEA should ideally be between 0.02 and 0.07, and the CFI and TLI should

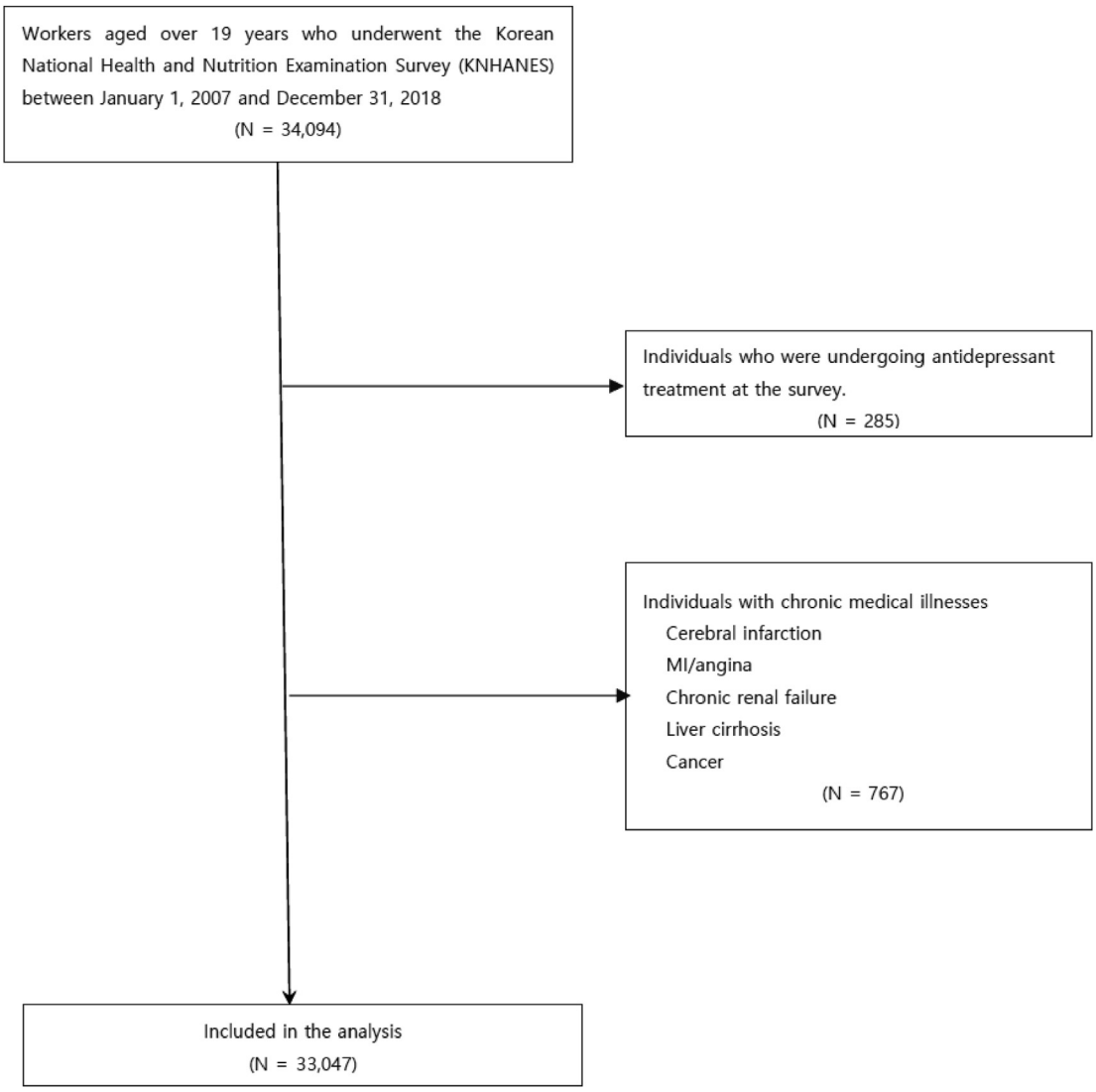

Fig. 1. Overview of the study participant selection.

be >0.90 [13]. The significance of the indirect effect was tested using the bootstrapping method. A 95% bias-corrected confidence interval was generated by bootstrapping with 200 re-samples. If the 95% confidence interval (CI) excluded zero, the indirect effect was considered significant. All statistical analyses were performed using STATA version 17.0 (StataCorp LLC., College Station, TX, USA).

3. Results

3.1. Sociodemographic and occupational characteristics of the participants according to suicidal ideation

The sociodemographic and occupational characteristics of the participants according to suicidal ideation were shown in Tables 1 and 2. Workers who expressed suicidal ideation were more likely to be older, be female, have a marital status of other (eg, divorced or bereaved), be smokers, be depressed, have lower education and income levels, have a shorter sleep duration, and have a greater frequency of alcohol consumption than those who did not express suicidal ideation. Additionally, the suicidal ideation group was more involved in shift work and a higher proportion worked in service, agricultural, forestry, and fishery areas and elementary occupations relative to the non-suicidal ideation group. In terms of employment status, workers with suicidal ideation were more likely to be unpaid family workers when compared with control group. Regarding working hours according to the shift pattern type, while daytime workers showed no difference in working hours according to their experience of suicidal ideation, longer working hours were observed in shift workers with suicidal ideation than in those without suicidal ideation.

3.2. Association between shift work and the development of suicidal ideation

In the fully adjusted model, compared with daytime workers, shift workers had a 1.33• greater risk of suicidal ideation (OR = 1.33, 95% CI = 1.17–1.52, $p < 0.001$). Specifically, an irregular rotating shift was associated with a 1.92• greater risk of suicidal ideation than daytime workers (OR = 1.92, 95% CI = 1.29–2.86, p = 0.001). Further, fixed-night and 24-h rotating shifts were associated with 1.75• and 1.58• greater risk of suicidal ideation, respectively (fixed-night shift: OR = 1.75, 95% CI = 1.32–2.31, $p < 0.001$; 24-h rotating shift: OR = 1.58, 95% CI = 1.06–2.36, p = 0.024) (Table 3, Model 4).

Table 1
Sociodemographic characteristics of the participants according to suicidal ideation.

	Without suicidal ideation (n = 31,256)	With Suicidal ideation (n = 1791)	p-value
	Mean ± SD or n (%)	Mean ± SD or n (%)	
Age	46.81 ± 0.08	48.61 ± 0.37	<0.001
Sex			
Men	16,685 (96.07)	682 (3.93)	<0.001
Women	14,571 (92.93)	1109 (7.07)	
Marital status			
Married	23,167 (95.20)	1167 (4.80)	<0.001
Never married	5406 (94.10)	339 (5.90)	
Other	2683 (90.40)	285 (9.60)	
Final degree			
Less than elementary school	4789 (89.78)	545 (10.22)	<0.001
Middle school	3170 (93.79)	210 (6.21)	
High school diploma	10,903 (94.87)	590 (5.13)	
College degree or higher	12,394 (96.53)	446 (3.47)	
Income status			<0.001
1st quartile	6480 (92.20)	548 (7.80)	
2nd quartile	8182 (94.37)	488 (5.63)	
3rd quartile	8275 (95.20)	417 (4.80)	
4th quartile	8319 (96.10)	338 (3.90)	
Alcohol consumption frequency			
≤1 time/month	9039 (94.16)	561 (5.84)	<0.001
2–4 times/month	13,845 (94.88)	747 (5.12)	
2–3 times/week	5883 (95.60)	271 (4.40)	
≥4 times/week	2489 (92.15)	212 (7.85)	
Smoking status			
Never smoker	14,709 (94.85)	799 (5.15)	0.044
Smoker	16,547 (94.34)	992 (5.66)	
Sleep duration	6.89 ± 0.01	6.65 ± 0.04	<0.001
Depressive symptoms			
No	29,590 (96.98)	921 (3.02)	<0.001
Yes	1666 (65.69)	870 (34.31)	

Table 2
Occupational characteristics of the participants according to suicidal ideation.

	Without suicidal ideation (n = 31,256)	With suicidal ideation (n = 1791)	p-value
	Mean ± SD or n (%)	Mean ± SD or n (%)	
Shift work patterns			
Daytime shift	25,560 (94.87)	1381 (5.13)	
Fixed-evening shift	2847 (93.44)	200 (6.56)	<0.001
Fixed-night shift	760 (91.13)	74 (8.87)	
Regular day and night rotating shift;	973 (95.86)	42 (4.14)	
24-h rotating shift	447 (92.93)	34 (7.07)	
Split shift	313 (92.60)	25 (7.40)	
Irregular rotating shift	356 (91.05)	35 (8.95)	
Occupation			
Managers	702 (95.77)	31 (4.23)	<0.001
Professionals	6414 (96.10)	260 (3.90)	
Office workers	4959 (96.44)	183 (3.56)	
Service workers	3315 (93.49)	231 (6.51)	
Sales workers	3493 (94.84)	190 (5.16)	
Agricultural, forestry & fishery workers	2713 (90.43)	287 (9.57)	
Craft and related trades workers	2463 (95.43)	118 (4.57)	
Plant and machine operators and assemblers	2676 (95.98)	112 (4.02)	
Elementary occupations	4448 (92.21)	376 (7.79)	
Armed forces	73 (96.05)	3 (3.95)	
Employment status			
Wage workers	20,830 (95.25)	1038 (4.75)	<0.001
Owner-operators & employers	8585 (94.00)	548 (6.00)	
Unpaid family worker	1841 (89.98)	205 (10.02)	
Average work time	42.08 ± 0.10	42.71 ± 0.50	0.209
Daytime shift	41.95 ± 0.11	41.48 ± 0.53	0.377
Shift work	42.61 ± 0.28	46.88 ± 1.19	<0.001

3.3. Mediation effects of working hours, sleep duration, and depressive mood on the association between shift work and the development of suicidal ideation

All the Variance Inflation Factors (VIF) values are lower than 3, which indicates a low correlation among independent variables under ideal conditions. The results of the mediating effects of working hours, sleep duration, and depressive mood on the association between shift work and the risk of suicidal ideation are shown in Table 4 and Fig. 2. The model demonstrated a good fit ($\chi 2 = 9237.276$, df = 46, $p < 0.001$, RMSEA = 0.020, CFI = 0.999, TLI = 0.936). Shift work had both direct and indirect effects on the

Table 3
Association between shift work patterns and the development of suicidal ideation.

Shift work patterns	Model 1[a]			Model 2[b]			Model 3[c]			Model 4[d]		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Daytime shift	1			1			1			1		
Shift work (total)	1.40	1.24, 1.57	<0.001	1.29	1.15, 1.45	<0.001	1.27	1.12, 1.44	<0.001	1.33	1.17, 1.52	<0.001
Fixed-evening shift	1.26	1.08, 1.48	0.003	1.15	0.98, 1.35	0.081	1.13	0.95, 1.34	0.169	1.15	0.96, 1.37	0.126
Fixed-night shift	2.03	1.58, 2.60	<0.001	1.62	1.26, 2.09	<0.001	1.65	1.25, 2.17	<0.001	1.75	1.32, 2.31	<0.001
Regular day and night rotating shift	0.96	0.70, 1.32	0.802	1.04	0.75, 1.42	0.831	1.03	0.73, 1.44	0.886	1.16	0.82, 1.64	0.392
24-h rotating shift	1.61	1.12, 2.30	0.009	1.56	1.09, 2.24	0.016	1.40	0.95, 2.08	0.092	1.58	1.06, 2.36	0.024
Split shift	1.44	0.95, 2.17	0.085	1.28	0.84, 1.94	0.250	1.48	0.94, 2.32	0.090	1.43	0.91, 2.24	0.119
Irregular rotating shift	2.05	1.44, 2.92	<0.001	2.08	1.45, 2.97	<0.001	1.88	1.27, 2.80	0.002	1.92	1.29, 2.86	0.001

[a] Adjustment for age and sex.
[b] Adjustment for a variables + marital status, education, income, alcohol consumption frequency, and smoking status.
[c] Adjustment for b variables + sleep duration and depressive symptoms.
[d] Adjustment for c variables + occupation, employment status, and working hours.

Table 4
Mediation effects of working hours, sleep duration, and depression on the association between shift work and the development of suicidal ideation.

Model pathways	Coefficient	Standardized coefficient	Bootstrap SE	p-value
Direct effect				
Working hours ←				
Shift work	0.638	0.014	0.289	0.027
Sleep duration ←				
Shift work	−0.072	−0.022	0.017	<0.001
Working hours	−0.008	−0.111	0.0004	<0.001
Depressive mood ←				
Shift work	0.006	0.009	0.004	0.105
Working hours	0.0003	0.018	0.0001	0.004
Sleep duration	−0.009	−0.041	0.001	<0.001
Suicidal ideation ←				
Shift work	0.011	0.019	0.003	0.001
Working hours	0.0001	0.008	0.0001	0.140
Sleep duration	−0.004	−0.024	0.001	<0.001
Depressive mood	0.301	0.354	0.009	<0.001
Indirect effect				
Suicidal ideation ←				
Shift work	0.003	0.004	0.001	0.031
Total effect				
Suicidal ideation ←				
Shift work	0.014	0.023	0.003	<0.001

Adjustment age, sex, marital status, education, income, alcohol intake, smoking, shift work pattern, occupation, employment status.

risk of suicidal ideation (indirect effect: $\beta = 0.004$, $p = 0.031$; direct effect: $\beta = 0.019$, $p = 0.001$). In terms of a mediating effect of working hours on the association between shift work and suicidal ideation, compared with daytime workers, shift workers were significantly more likely to have longer working hours (shift work → working hours: $\beta = 0.014$, $p = 0.027$). Additionally, longer working hours were significantly associated with the risk of depressive mood but not related to suicidal ideation directly (working hours → depressive mood: $\beta = 0.018$, $p = 0.004$; working hours → suicidal ideation: $\beta = 0.008$, $p = 0.140$). Lastly, depressive symptom was significantly associated with the risk of suicidal ideation (depressive mood → suicidal ideation: $\beta = 0.354$, $p < 0.001$).

Regarding a mediating effect of sleep duration on the association between shift work and suicidal ideation, compared with daytime workers, shift workers were significantly more likely to have shorter working hours (shift work → sleep duration: $\beta = -0.022$, $p < 0.001$). In addition, shorter sleep duration was significantly associated with the risk of depressive mood and suicidal ideation (sleep duration → depressive mood: $\beta = -0.041$, $p < 0.001$; sleep duration → suicidal ideation: $\beta = -0.024$, $p < 0.001$). Lastly, depressive mood was significantly associated with the risk of suicidal ideation (depressive mood → suicidal ideation: $\beta = 0.354$, $p < 0.001$). Next, the serial mediating effects of working hours and sleep duration on the association between shift work and suicidal ideation, were assessed. Compared with daytime workers, shift workers were significantly more likely to have longer working hours (shift work → working hours: $\beta = 0.014$, $p = 0.027$) and longer working hours were significantly related to shorter sleep duration (working hours → sleep duration: $\beta = -0.111$, $p < 0.001$). Additionally, shorter sleep duration was significantly associated with the risk of depressive mood and suicidal ideation (sleep duration → depressive mood: $\beta = -0.041$, $p < 0.001$; sleep duration → suicidal ideation: $\beta = -0.024$, $p < 0.001$). Lastly, depressive mood was significantly associated with the risk of suicidal ideation (depressive mood → suicidal ideation: $\beta = 0.354$, $p < 0.001$).

4. Discussion

The results of this study showed that compared with daytime workers, shift workers had a greater risk of suicidal ideation. In addition, there was a serial mediating effect of working hours, sleep duration, and depressive mood on the association between shift work and suicidal ideation.

This study revealed that shift workers had a 1.33• increased risk of suicidal ideation, which is consistent with previous studies [14,15]. The work pattern most strongly associated with suicidal ideation was an irregular rotating shift, followed by the fixed-night

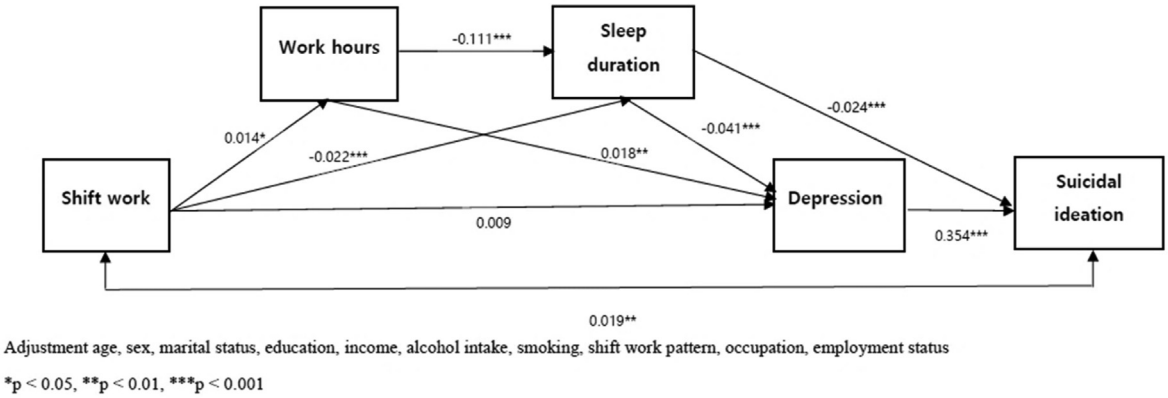

Fig. 2. Standardized factor loading for the partially mediated structural model.

and 24-h rotating shifts. Approximately 10 percent of the workforce is engaged in irregular and on-call shift times [16]. A recent study has reported that irregular shift patterns are associated with work stress, such as low job control, high job demand, effort-reward imbalance, job insecurity, and work-family conflict [16], which are associated with the risk of suicidal ideation [17]. In addition, given time, the duration and constancy of shift schedules are crucial factors for adapting to shift patterns. Therefore, an irregular rotating shift may not guarantee that employees can adjust to circadian disorganization [2]. Shift workers who failed to adapt to the circadian rhythm are more vulnerable to shift work and mood disorders, which result in an increased risk of suicidal ideation [1,2,14]. Additionally, workers with a fixed-night shift are prone to suffer from circadian misalignment, where the circadian rhythms and 24-h light/dark cycle become uncoupled, negatively impacting on both sleep and alertness. Therefore, shift workers with a fixed-night schedule are vulnerable to both insomnia and sleepiness because daytime sleep is short and fragmented, resulting in homeostatic sleep debt and blunted circadian arousal at nighttime [2]. According to previous studies, insomnia is associated with suicidal ideation. Further, lower alertness during working hours causes cognitive deficits and low performance, leading to low self-esteem, which is a risk factor for suicidal ideation [7,18,19].

Moreover, it is possible that those with a fixed-night shift tended to be less socially engaged, likely due to their nocturnal work schedules. Social connectedness is important to mental health; depressive mood related to shift work is exacerbated by social isolation and decreased social participants [7]. Therefore, socially isolated shift work may cause a greater risk of suicidal ideation. The 24-h rotating shift workers are defined as those with 24 h-on/24 h-off rosters, such as janitors. In these cases, sleeping at night is usually permitted when there is no special event; therefore, the degree of circadian misalignment is less than in fixed-night and irregular rotating patterns. However, sleep environments are varied, alternating between home and work once every two days, and it is difficult to control for light, temperature, and noise when sleeping at work, which can lead to sleep disturbances [20]. In addition, when something special happens at night, shift workers with 24-h rotating patterns must be alert, which can cause circadian disorganization. Therefore, 24-h rotating shift workers had greater risk of suicidal ideation compared with healthy controls.

The results of current study revealed that shift workers had longer working hours and shorter sleep durations, which also increased the risk of suicidal ideation mediated by depressive mood. According to previous studies, longer working hours and shorter sleep durations are associated with depression [4,10,21]. Further, depression is a crucial risk factor of suicidal ideation [22]. This is consistent with our results: excluding the mediating effects of depressive mood, shorter sleep durations were directly associated with the risk of suicidal ideation while longer working hours were not. This revealed that when depressive mood was removed as a mediating factor, shorter sleep duration remained linked with suicidal ideation through other factors.

According to a previous review study, serotonergic dysfunction, mood dysregulation, hopelessness, cognitive deficits, and impulsivity are potential mediators of the short sleep duration and suicide relationship [19]. Among these factors, cognitive deficits and impulsivity may be distinguished independently from depression. In shift workers, the circadian alerting signal and sleep pressure become uncoupled; they need to be awake when not biologically prepared. Therefore, they can suffer from hypofrontality, including diminished executive function and impulsivity, which may result in an increased risk of suicidal ideation [8].

We found serial mediating effects of working hours, sleep duration, and depressive mood on the association between shift work and suicidal ideation. Indeed, when shift workers had long working hours, sleep duration was decreased sequentially, which resulted in an increased risk of suicidal ideation, which was partially mediated by depressive mood. Short et al. [23] have reported that shift workers with 4 h-on/8 h-off rosters sleep 1 h more per day than those with 6 h-on/6 h-off and 1.3 h more per day than those with 8 h-on/8 h-off. This confirms our data that longer working hours lead shorter sleep durations in shift workers.

4.1. Limitations

There are several potential limitations we should consider. First, inflated associations and reverse causality are possible because the study design was cross-sectional. Second, as working hours, sleep duration, depressive mood, and suicidal ideation were assessed based on self-reported questionnaires, the results may be affected by response bias. Third, we used only one item to assess depression. Using one item originally designed as part of a multi-item scale may not have provided a complete concept of depression because other depressive symptoms (neurovegetative and energy symptoms) might have been overlooked [24,25]. Future studies should use a valid and reliable scale that includes various aspect of depressive symptoms. Fourth, although we adjusted a range of covariates, there were several variables reflecting individual differences in tolerance for shift work, such as the morningness/eveningness trait, genetic polymorphism of circadian genes, and the length of working as a shift worker, which were not assessed [2].

5. Conclusions

The 24/7 operation system is necessary for the modern industrialized economy and approximately 20% of workers are involved in shift work. However, circadian misalignment causes a range of mental illnesses. This study revealed that shift workers had a greater risk of suicidal ideation. The shift patterns significantly associated with suicidal ideation were irregular rotating, fixed-night, and 24-h rotating shifts. The pathway analysis revealed serial mediating effects of working hours, sleep duration, and depressive mood on the association between shift work and suicidal ideation. Taken together, these data showed that shift workers are vulnerable to sleep disturbance and various psychiatric symptoms, such as depressive mood and suicidal ideation; therefore, it is important to establish various policies that guarantee appropriate working hours and sufficient sleep time.

Credit author statement

Sun-Young Kim: conceptualization, methodology, software, formal analysis, writing – original draft, **Mi Yeon Lee:** methodology, supervision, **Soo In Kim:** supervision, writing – review & editing, **Weon-Jeong Lim:** conceptualization, supervision, project administration.

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None.

Conflict of interest

The authors report no conflicts of interest.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2022.03.016.

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