

Working Conditions and Mental Health Status Related With Occupational Injury of Korean Outdoor Workers

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Objective: This study investigated the working conditions and mental health status linked to occupational injury among Korean outdoor workers. **Methods:** Socioeconomic and occupational characteristics were collected using self-reported questionnaires from 26,468 paid workers selected using the 5th Korean Working Conditions Survey. The relationships among mental health issues, occupational injury, and working outdoors were estimated by logistic regression. **Results:** Outdoor workers were relatively older with lower educational levels and income, worked longer, and had greater exposure to occupational hazards, higher occupational injury rate, significantly higher risk of sleep disturbances, and higher occupational injury rates due to sleep disturbances than non-outdoor workers. **Conclusions:** There was a significant relationship among working outdoors, sleep quality, and mental health-related issues due to exposure to occupational hazards. Specific occupational health and safety strategies are needed to protect the mental health of outdoor workers.

Keywords: anxiety, depression, Korean working conditions surveys, outdoor workers, sleep disturbance

In general, the primary and most effective protective strategy for reducing outside hazard exposure is to ensure that a person works indoors. This protection strategy is unsuited for those whose workplace is outdoors. Outdoor workers are vulnerable to exposure to hazardous factors in their workplaces such as noise, vibration, heat, cold, and dust which are risk factors for occupational health and safety. Excessive heat or cold exposure is likely to negatively affect workers' health and safety directly and systematically.^{1,2} However, accurately assessing the levels of exposure to noise, vibration, and dust in outdoor workplaces is challenging because of a combination

of occupational and environmental exposure sources.³ The systematic effects of exposure to high and low temperatures and of unknown levels of exposure to various workplace hazards increase the vulnerability of outdoor workers in terms of health and safety. Previous studies have reported that outdoor working environments act as physical and physiological harmful factors, increasing mortality and morbidity.^{4,5}

It is now well established that the outside environment promotes physiological and psychological adaptation among humans that might affect their mental health status.⁶ However, the influence of the outside environment on the mental health of outdoor workers remains unclear. In Korea, there are four markedly different seasons with extremely hot and cold temperatures and varying dust levels; therefore, understanding the mental health status of outdoor workers in relation to their outside working conditions is important.

The objectives of this study were to analyze and understand the working conditions and the current mental health status of outdoor workers, especially in terms of depression, anxiety, and sleep disturbance, and the relationship between mental health status and occupational injury among Korean outdoor workers.

METHODS

Data and Study Participants

This study used data from the 5th Korean Working Conditions Survey (KWCS), which was undertaken by the Occupational Safety and Health Research Institute (OSHRI) of Korea in 2017. The survey methods and structure of the KWCS are the same as those of the European Working Condition Survey.⁷ The 2017 KWCS conducted multistage random sampling, based on region, sex, and age, to better understand these characteristics in the Korean working population over the age of 15 and examined the working conditions, occupational characteristics, health status, and socioeconomic demographics of the economically active population in Korea.⁸ Trained professional interviewers gathered information using questionnaires involving face-to-face interviews at the homes of participants. All data were anonymized.⁹ The KWCS data are open to the public and the whole dataset is available via an OSHRI website.¹⁰ The 5th KWCS had 50,205 participants. Non-paid workers such as the self-employed or non-paid familial workers (20,153 individuals) and those with incomplete data (3584 individuals) were excluded. Finally, 26,468 individuals were selected for this study (Fig. 1).

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Review Board (IRB) of Gachon University Gil Medical Center (IRB No.2019-278) and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. All data from the fifth Korean Working Conditions Survey were collected with written informed consent from all participants and the data were anonymized.

Outdoor Workers

An outdoor worker was defined in terms of responses to the following question; "Where is your main place of work?" Possible answers were "My employer's or my own business premises (office,

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Disclosure of potential conflicts of interest: None declared.

Clinical significance: This cross-sectional study identified a significant relationship between working outdoors, sleep quality, and injury experience among outdoor workers. Due to ongoing occupational and environmental changes, outdoor workers may be exposed to increased harmful factors in the future. Therefore, targeted measures and policies are needed to protect their health.

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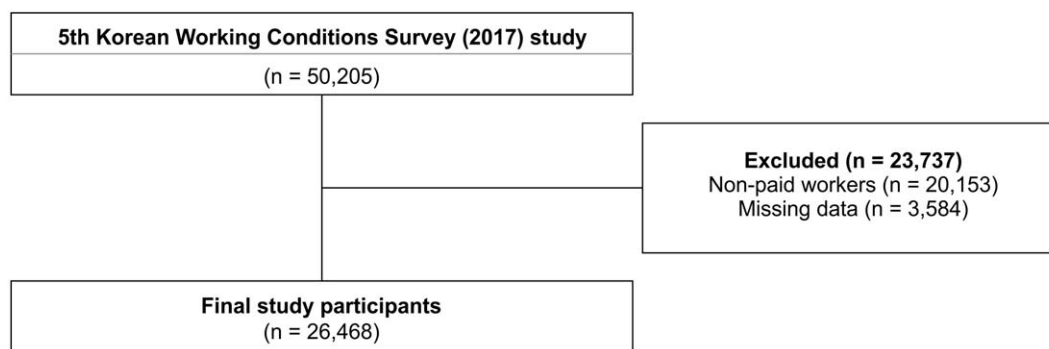


FIGURE 1. Schematic diagram depicting the flow of participants in this study according to the working conditions and mental health status of Korean outdoor workers.

factory, shop, school, etc),” “Client premises,” “A car or another vehicle,” “An outside site (construction site, agricultural field, streets of a city),” “My own home,” or “Other.” Outdoor workers were defined as participants who had answered, “An outside site (construction site, the agricultural field, streets of a city).”

Mental Health Issues

Two questionnaire items were used to identify subjective symptoms of depression and anxiety. To the question “Have you suffered from the following health problems during the past 12 months?” with the options of “depression” and “anxiety,” the two response options provided were “at any time” and “never.” Participants who responded to the option “at any time” (regrouped as “yes”) were considered to have experienced the subjective symptoms of depression or anxiety, and those who responded to the option “never” (regrouped as “no”) were considered to have not experienced these issues in the past 12 months. The question concerning sleep disturbances consisted of the following subsections: (1) difficulty falling asleep, (2) difficulty maintaining sleep, and (3) extreme fatigue after waking up. To determine the frequency of these issues, the options were “every day,” “several times a week,” “several times a month,” “rarely,” “none,” “no comment,” or “refuse to comment.” The workers were considered to have poor sleep quality for each part if they responded that there were sleep disturbances “every day” or “several times a week.”

Working Conditions and Occupational Injury

Working conditions included occupational classification, working hours, and exposure to vibration, noise, heat, cold, and dust. The occupation classification consisted of four categories: office workers (managers, professionals and related workers, and office workers); services and sales workers; agriculture, forestry, and fisheries workers; and manual workers (technicians and related workers, equipment and machinery operators, and assembly workers) in accordance with a previous study.¹¹ In Korea, weekly working hours are limited to 52 hours as specified by the Labor Standards Act.¹² In terms of total working hours per week, two groups were formed based on a cut-off value of 52 hours. Exposure to hazardous factors was defined as exposure to vibration, noise, high temperature, low temperature, and dust during at least half or more of the working hours involved. The occupational injury was defined in terms of responding “Yes” to having experienced an injury at their workplace in the last year.

Covariates

The general factors included sex, age, education, and monthly income. Age was classified into less than 30 years old, 30 to 59 years old, and more than or equal to 60 years old. Education

level was classified into three categories, namely, those with below middle school graduation, those with high school graduation, and those with graduation from college or higher. Monthly income was classified into less than \$1,000, \$1,000 to \$1,999, \$2,000 to \$2,999, and more than or equal to \$3,000.

Statistical Analysis

The weighed proportion of outdoor workers among paid workers in Korea was calculated according to the International Standard Industrial Classification (ISIC) (United Nations Revision 4). A Chi-squared test was performed to compare the characteristics of the outdoor workers according to baseline characteristics. A multiple logistic regression analysis was performed to analyze the relationship between working outdoors and specific mental health issues after adjusting for age, sex, education, income, occupational classification, working hours, exposure to vibration, exposure to noise, exposure to heat, exposure to cold, and exposure to dust. The cumulative prevalence rates and standard errors in terms of occupational injury were estimated according to the total number of sleep-related issues among outdoor workers within the Korean paid working population. All statistical analyses were performed using SAS 9.4 software (SAS Institute Inc., Cary, NC).

RESULTS

Table 1 shows the proportion of outdoor workers according to the type of employment in relation to all participants in the 5th KWCS before exclusion. Altogether 8254 (16.4%) workers were working outdoors among 50,205 participants. The proportion of outdoor workers comprised 47.2%, 24.7%, and 9.1% of the non-paid familial workers, self-employed, and paid workers, respectively.

The outdoor workers general characteristics were demonstrated in Table 2. The prevalence of working outdoors was 12.5%

TABLE 1. Number (*n*) and Proportion (%) of Outdoor Workers According to Employment Type in 5th Korean Working Conditions Survey (*n* = 50,205)

Employment Type	Outdoor Work			
	No		Yes	
	<i>n</i>	%	<i>n</i>	%
Self-employed	13,337	75.3	4,378	24.7
Paid workers	27,356	90.9	2,752	9.1
Non-paid family members	1,258	52.8	1,124	47.2
Total	41,951	83.6	8,254	16.4

TABLE 2. Baseline Characteristics of Study Participants ($n = 26,468$) Differentiated Between Non-outdoor and Outdoor Workers

Characteristics	Outdoor Work				P-Value
	No		Yes		
	N	%	N	%	
Total	24,369	92.1	2,099	7.9	
Gender					<0.0001
Male	11,405	87.5	1,634	12.5	
Female	12,964	96.5	465	3.46	
Age, yrs					<0.0001
<30	3,021	96.5	111	3.5	
30–59	18,212	93.2	1,322	6.8	
≥60	3,136	82.5	666	17.5	
Education level					<0.0001
Middle school	2,081	78.4	572	21.6	
High school	8,432	90.4	892	9.6	
College or higher	13,856	95.6	635	4.4	
Monthly household income (\$)					<0.0001
<1,000	2,138	89.3	255	10.7	
1,000–1,999	10,885	93.3	778	6.7	
2,000–2,999	7,689	90.9	772	9.1	
≥3,000	3,657	92.6	294	7.4	
Occupational classification					<0.0001
Office workers	3,959	94.0	254	6.0	
Service and sales workers	10,179	97.3	284	2.7	
Agriculture, forestry, and fisheries	3,751	96.2	148	3.8	
Manual workers	6,480	82.1	1,413	17.9	
Long working hours (>52 h/wk)					<0.0001
No	20,845	92.5	1,701	7.5	
Yes	3,524	89.9	398	10.1	
Exposure to vibration					<0.0001
No	21,623	94.2	1,327	5.8	
Yes	2,746	78.1	772	21.9	
Exposure to Noise					<0.0001
No	22,233	93.7	1,506	6.3	
Yes	2,136	78.3	593	21.7	
Exposure to heat					<0.0001
No	21,943	94.5	1,286	5.5	
Yes	2,426	74.9	813	25.1	
Exposure to cold					<0.0001
No	22,289	93.6	1,519	6.4	
Yes	2,080	78.2	580	21.8	
Exposure to dust					<0.0001
No	22,675	94.3	1,380	5.7	
Yes	1,694	70.2	719	29.8	
Depression					0.0198
No	23,840	92.1	2,037	7.9	
Yes	529	89.5	62	10.5	
Anxiety					0.0780
No	23,726	92.1	2,030	7.9	
Yes	643	90.3	69	9.7	
Difficulty falling asleep					<0.0001
No	23,364	72.5	1,906	7.5	
Yes	1,005	83.9	193	16.1	
Waking up repeatedly during sleep					<0.0001
No	23,537	92.5	1,916	7.5	
Yes	832	82.0	183	18.0	
Waking up with feeling of exhaustion and fatigue					<0.0001
No	23,448	92.5	1,899	7.5	
Yes	921	82.2	200	17.8	
Previous occupational injury					<0.0001
No	24,103	92.3	2,021	7.7	
Yes	266	77.3	78	22.7	

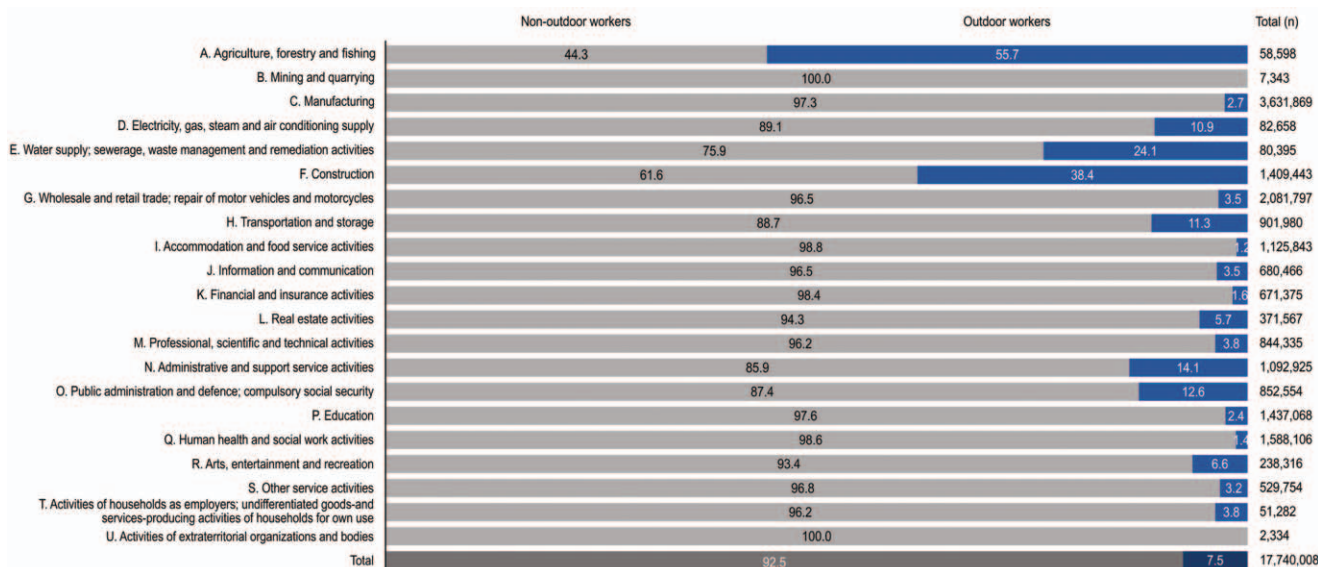


FIGURE 2. Weighted proportion of outdoor workers in the different industries according to the International Standard Industrial Classification among all paid workers in Korea.

($n = 1634$) for male workers and 3.5% ($n = 465$) for female workers. Significant differences were observed between working outdoors and sex, age, education level, monthly household income, occupational classification, long working hours, exposure to vibration, noise, heat, cold and dust, depression, poor sleep qualities (falling asleep, sleep maintenance, and daytime fatigue), and occupational injury experience ($P < 0.001$).

Figure 2 shows the weighted proportion of outdoor workers among paid workers according to the ISIC. The group with the highest percentage of outdoor workers was group A (agriculture, forestry, and fishing group) with 55.7%, followed by group F (construction) with 38.4%, and group E (water supply, sewerage, waste management, and remediation activities) with 24.1%. Groups with the fewest outdoor workers were group B (mining and quarrying, 0%) and group U (activities of extraterritorial organizations and bodies, 0%), followed by group I (accommodation and food service activities, 1.2%) and group Q (human health and social work activities, 1.4%).

The association between working outdoors and sleep-related issues is shown in Table 3. The odds ratios (ORs) and confidence intervals (CIs) were calculated using logistic regression analysis. Non-outdoor workers served as a reference group. In model 1, after adjusting for general factors (age, sex, education, income, occupational classification, and working hours), the ORs for “difficulty falling asleep,” “waking up repeatedly during sleep,” and “waking up with feelings of exhaustion and fatigue” were 2.82 (95% CI 2.31 to 3.45), 3.32 (95% CI 2.69 to 4.09), and 3.19 (95% CI 2.61 to 3.90), respectively. In model 2, after adjusting for both general and occupational exposure factors (exposure to vibration, noise, heat, cold, and dust), the ORs for “difficulty falling asleep,” “waking up repeatedly during sleep,” and “waking up with feelings exhaustion and fatigue” were 1.92 (95% CI 1.68 to 2.19), 2.13 (95% CI 1.71 to 2.67), and 2.07 (95% CI 1.67 to 2.56), respectively. However, depression and anxiety were not statistically significant in relation to working outdoors in both models 1 and 2.

Figure 3 shows the cumulative weighted prevalence rates for previous injury experience according to the total number of sleep-related issues in this study. Even when there were no sleep-related issues, the sleep-disturbance rate of outdoor workers was higher,

and when there were sleep-related issues, the accident experience rate tended to be higher in outdoor workers than in non-outdoor workers. The accident experience rate for outdoor workers with all three sleep-related issues was 4.1% compared with 1.1% for non-outdoor workers.

DISCUSSION

This study investigated the workplace environment, socioeconomic status, and mental health issues focused on the sleep problems linked to the occupational injury among Korean outdoor workers.

TABLE 3. Odds Ratio and 95% Confidence Intervals for Mental Health Problems Differentiated Between Non-outdoor ($n = 24,369$) and Outdoor Workers ($n = 2,099$) Using a Logistic Regression Model

	Odds Ratio (95% Confidence Interval)	
	Model 1	Model 2
Depression		
Non-outdoor workers	1.00 (reference)	1.00 (reference)
Outdoor workers	0.99 (0.67–1.48)	0.85 (0.57–1.28)
Anxiety		
Non-outdoor workers	1.00 (reference)	1.00 (reference)
Outdoor workers	1.16 (0.85–1.60)	0.96 (0.69–1.33)
Difficulty falling asleep		
Non-outdoor workers	1.00 (reference)	1.00 (reference)
Outdoor workers	2.82 (2.31–3.45)	1.92 (1.68–2.19)
Waking up repeatedly during the sleep		
Non-outdoor workers	1.00 (reference)	1.00 (reference)
Outdoor workers	3.32 (2.69–4.09)	2.13 (1.71–2.67)
Waking up with a feeling of exhaustion and fatigue		
Non-outdoor workers	1.00 (reference)	1.00 (reference)
Outdoor workers	3.19 (2.61–3.90)	2.07 (1.67–2.56)

Model 1: adjusted for age, sex, education, income, occupational classification, and working hours. Model 2: adjusted for age, sex, education, income, occupational classification, working hours, exposure to vibration, exposure to noise, exposure to heat, exposure to cold, and exposure to dust.

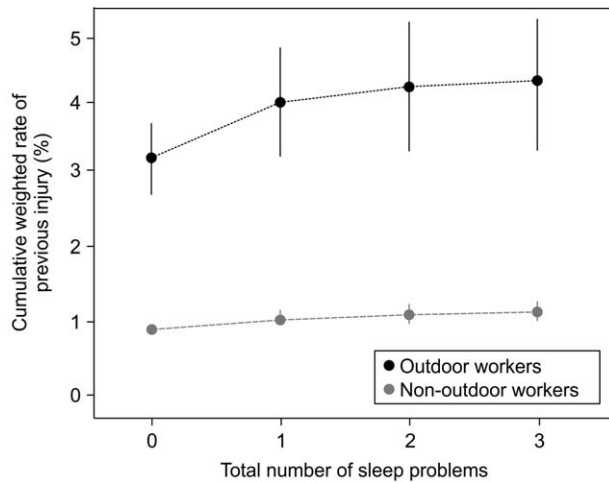


FIGURE 3. Cumulative rate (and standard error) of previous occupational injury related to the total number of sleep problems in non-outdoor and outdoor workers in this study.

Outdoor workers were relatively older, with lower educational levels, lower income, and worked longer than non-outdoor workers. Outdoor workers were more exposed to various hazardous factors such as noise, vibration, dust, heat, or cold than non-outdoor workers. Outdoor workers had mental health issues including depression, anxiety, sleep disturbances, and occupational injury. Specifically, a significant relationship was found between working outdoors and sleep disturbances even after adjusting for socioeconomic status, working conditions, and occupational characteristics, and sleep disturbances were closely linked to occupational injury.

The poorer mental health of outdoor workers may be influenced by their lower socioeconomic status than non-outdoor workers. Those with low education and low income have been found to be more vulnerable to mental health issues such as depression or anxiety than their counterparts as they were socioeconomically disadvantaged.¹³ Both low income and low education levels have been closely linked to psychological distress, which could negatively affect sleep quality and quantity.¹⁴ Engagement by occupational health and safety professionals is needed to address these mental health issues among outdoor workers.

Outdoor workers may inhale more harmful substances such as dust or chemicals, depending on their workplace environment than non-outdoor workers. One study that measured dust and endotoxin concentrations in composting plants found nearly twice as much dust and endotoxin in the outdoor environment than in the indoor environment.¹⁵ According to a study in Italy, toluene, benzene, and xylene are significantly present in urban outdoor environments.¹⁶ Exposure to such outside airborne particles could increase the risk of mental health issues.¹⁷ Noise causes various reactions in the human body, and sleep disorders are one of the extra-auditory effects caused by noise. Intermittent noise above 45 dB(A) may delay the time to falling asleep by several minutes up to 20 minutes. In addition, final awakening arrives early causing changes in sleep stages and structure, leading to decreased subjective satisfaction with sleep quality.¹⁸ Both vibration and noise have various psychological effects that can be risk factors for poor mental health including sleep disturbance, anxiety, and depression.^{19,20} Noise or vibration exposure from the outside environment has been reported to induce overall nervous systemic hyperarousal and interference which are significantly related to sleep initiation, prolonged sleep, and early awakening.²⁰

Contrary to expectations, this study did not find a significant relationship between depression or anxiety and working outdoors after adjusting for covariates. Occupational hazardous factors have been linked to workers' depression or anxiety. Certain psychosocial factors and long working hours have been shown to have greater effects on depression or anxiety levels than exposure to biomechanical, physical, or chemical hazardous factors.^{21,22} However, we did find a significant relationship between sleep problems and working outdoors. Sleep-related issues are bidirectionally related to both anxiety and depression²³ and can act as predictors of various mental health issues including anxiety and depression.²⁴ More focused attention on sleep-related issues could help reduce the burden of mental health issues among outdoor workers.

Occupational injury rates were higher in outdoor workers than non-outdoor workers. Traditional outdoor workers such as agriculture, construction, and transportation workers are more likely to develop heat strain which can lead to poor physical performance and occupational injury.²⁵ One study reported an accident rate increase of 1.002 (95% CI 1.002 to 1.003) in all 16 areas of Quebec, Canada, as the outdoor summer temperature increased by 1 °C.²⁶ Moreover, high-temperature exposure is associated with a decrease in productivity, with a report of a 0.57% decrease in working time and a 0.74% increase in rest time when the temperature rose by 1 °C.²⁷ Cold environments can reduce agility. Moreover, heavy and large protective equipment can impede movement and reduce collaboration increasing slippage and falls which can threaten worker safety.²⁸ Outdoor work in cold environments can lead to respiratory and cardiovascular disease resulting in sickness or absenteeism leading to lower productivity and even death from illness and accidents.²⁹ A Japanese study conducted a questionnaire survey and sensitized temperature measurements on traffic control workers and building construction workers working outside in winter. These outdoor workers complained of shoulder pain, finger aching, neck stiffness, and back pain.³⁰

Sleep disorders have been significantly linked to excessive absenteeism, reduced productivity, reduced job satisfaction, and increased risk of accidents, according to a study that evaluated 30 papers that had analyzed the relationship between insomnia and work.³¹ The relationship between sleep disorders and sleep disturbance is well-known, with a meta-analysis of 268,332 workers in 27 observational studies showing that workers with sleep-related issues were 1.62 times (1.43 to 1.84) more likely to be injured than those without such issues. Another study has shown that approximately 13% of workers' injuries may be due to sleep-related issues.³² Moreover, sleep disorders affect traffic accidents with one-fourth of occupational drivers in Iran having experienced road accidents, 29% having experienced sleepiness while driving, and 40% having poor sleep quality, according to a study of Iranian occupational drivers.³³ One study has suggested the possibility of using sleep disturbance as a predictor of occupational injuries.³⁴ The increased risk of sleep disturbance in relation to occupational injury among outdoor workers needs to be carefully considered by occupational health and safety professionals.

This study has several limitations. First, as this was a cross-sectional study, the quality of sleep in terms of whether outdoor work was being performed could not be assessed nor could causal relationships be determined. Second, the results were based on self-report questionnaires, which were not validated especially in relation to the definition used (outdoor workers) and the dependent variable (sleep disturbances). Recall or classification bias cannot be excluded because this was a retrospective self-report questionnaire study. Given these limitations, these findings cannot be readily extrapolated to all working conditions related to mental health. Specifically, the results of this study need to be considered in terms of the occupational classifications used and that, participants gave their own interpretations.

In this study, outdoor workers were shown to be vulnerable to physical harmful factors such as noise, vibration, heat, cold, and dust; to report sleep disorders more often than non-outdoor workers; and to have a high rate of injury experience. Outdoor workers are more vulnerable than non-outdoor workers both physically and mentally, and therefore, they require relevant targeted health and safety policies.

This cross-sectional study identified working conditions of Korean outdoor workers and a significant relationship between sleep quality and injury experience among outdoor workers. Due to ongoing occupational and environmental changes, outdoor workers may be exposed to increased harmful factors in the future. Targeted measures and policies are needed to protect their health.

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