

Research Article



# Multidimensional sleep quality of dependent self-employment workers

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Abbreviations

NSE: non-standard employment; DSE: dependent self-employment; OR: odds ratio;

## ABSTRACT

**Background:** The number of workers in non-standard employment (NSE) is increasing due to industrial change and technological development. Dependent self-employment (DSE), a type of NSE, was created decades ago. Despite the problems associated with this new type of employment, few studies have been conducted on the effects by DSE on health, especially sleep quality. This study aims to determine the relationship between DSE and sleep quality.

**Methods:** This study analyzed data of 50,250 wage workers from the fifth Korean Working Conditions Survey. Workers that did not respond or refused to answer any questions related to variables were excluded, and finally 36,709 participants were included in this study. A total of 2,287 workers (6.2%) were compared with non-DSE (34,422; 93.8%) workers, and multiple logistic regression analyses were applied.

**Results:** DSE status had a significant association with difficulty falling asleep (odds ratio [OR]: 1.331, 95% confidence interval [CI]: 1.178–1.504), difficulty maintaining sleep (OR: 1.279; 95% CI: 1.125–1.455), and extreme fatigue after waking up (OR: 1.331; 95% CI: 1.184–1.496). A multiple logistic regression of the variables for sleep quality in DSE showed a significant association with exposure to physical factors for all types of poor sleep quality as well as shift work for difficulty maintaining sleep with extreme fatigue after waking up. Long working hours and emotional labor were also associated with extreme fatigue after waking up.

**Conclusions:** This study shows a significant association between DSE and poor sleep quality, especially when workers were exposed to physical risk factors (noise, vibration, abnormal temperature, etc.) and shift work.

**Keywords:** Dependent self-employment; Non-standard employment; Sleep quality; Physical risks; Shift work

## BACKGROUND

The number of non-standard employment (NSE) workers has increased in the past few decades globally as the need for specific work tasks is increasing; such as dispatched labor, temporary replacement of absent workers, seasonal demand on workforce, work task with multiple employers, or alienated work from legal enforcement [1]. There is no official definition of the NSE, but it typically follows any type of work other than standard employment. The

CI: confidence interval; ILO: International Labor Office; EWCS: European Working Conditions Survey; OSH: occupational safety and health; OSHRI: Occupational Safety and Health Research Institute; KWCS: Korean Working Conditions Survey; KRW: Korean Won; REM: rapid eye movement.

#### Competing interests

The authors declare that they have no competing interest.

#### Authors contributions

Conceptualization: Lee SH; Data curation: Kang DY; Formal analysis: Lee JH, Kim UJ; Methodology: Lee WH; Project administration: Kang SK; Supervision: Choi WJ; Validation: Lee WH, Ham SH; Writing - original draft: Lee SH; Writing - review & editing: Lee SH, Kang SK.

International Labor Office (ILO) classified the NSE into 4 types: 1) temporary, 2) part-time, 3) temporary agency work involving multi-parties, and 4) dependent self-employment (DSE) [2]. Each employment type is distinguished from the standard employment.

The growth of NSE workers causes various work-related insecurities. Employment insecurity is one of the problems of NSE because workers can't reach to similar level of wages compare to those earned by standard work. NSE workers usually challenge to select one of 3 options to compensate for their lower wage; 1) long working hours or extra work, 2) multiple jobs, 3) taking irregular, unpredictable, and atypical work schedules [1]. These types of work can cause more occupational risks in general. In shipping industries, for example, workers are exposed to dangerous work environment with long working hours and tight schedules, which leads them to have a high chance of injuries [3]. Poor mental health is another issue of workers in NSE. Workers in NSE in the Republic of Korea expressed their experience of depressive mood and thoughts of suicide at work, and it is more frequent in women [4]. Among the 4 types of NSE, DSE is defined as a work of performing services under a civil or commercial contract receiving incomes and instructions from a single or multiple clients. Workers in DSE are usually out of the regulations of labor law or social security, but the number of DSE workers is increasing due to changes in business, technological development, and the increased demand for employment from firms [1]. According to the European Working Conditions Survey (EWCS) in 2015, 47% of participants who answered that they were "self-employed" were actually workers in DSE [5].

Workers in NSE is vulnerable due to unstable employment and poor working environments [3]. NSE status is associated with cardiovascular disease including hypertension [6], arthritis, and depression with suicidal ideation [7]. DSE, one of the new type of employment, has increased and widely spread in labor market along with changing the industrial structure [8]. Most studies on trends in DSE have focused on employment insecurity, or basic idea threatening occupational safety and health (OSH). However, there has been only a few studies for OSH of DSE status, especially for sleep quality.

Therefore, it is important to study the sleep quality as it is the cornerstone of mental health in workers. This study aims to determine the relationship between DSE and sleep quality as well as the characteristics of DSE in the Republic of Korea.

## METHODS

### Data source

The Occupational Safety and Health Research Institute (OSHRI) has conducted the Korean Working Conditions Survey (KWCS) based on the EWCS since 2006. Workers aged 15 years or more, the legally eligible age for work in Korea, participated in the survey through interviews [9]. The participants were randomly selected to represent the Korean working population. The survey contains questions on working conditions such as employment status, occupational classification, type of work, working hours, hazard exposure, and health effects [10]. The KWCS data is open data to general users and researchers, so raw data is available via proposal on the website of resources at OSHRI (<http://www.kosha.or.kr/eoshri/resources/KWCSDownload.do>).

### Study participants

The fifth KWCS in 2017, included a total of 50,250 workers. Among the participants, wage workers were selected since workers in DSE were classified as wage workers according to the KWCS. Self-employed workers with or without employees, unpaid family workers, or those that did not respond were excluded. Additionally, workers who refused to answer questions about DSE or questions of sleep quality. The cases of missing confounders were also excluded.

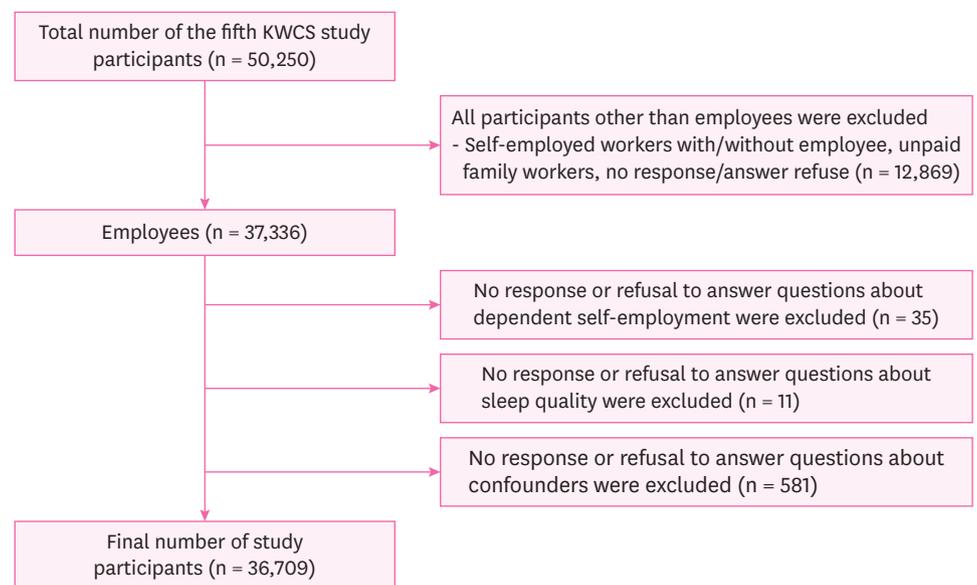
Among the 50,250 participants, 12,869 self-employed workers with or without an employee, unpaid family workers, and non-responders to the question were excluded. Then, workers who refused to answer the question on DSE ( $n = 35$ ) and sleep quality ( $n = 11$ ) were excluded as well. Missing information of confounders ( $n = 581$ ) were also excluded. Finally, 36,709 participants were included in this study (Fig. 1).

### Variables

The DSE worker was defined by the following question: "Do you have a job providing goods or services in person, or a job where income is related to the amount of work (depending on your job performance)? Examples: insurance agents, personal tutors, delivery men, golf club caddies, concrete mixer truck drivers, etc." Survey participants might choose the answer as follows: "yes," "no," "no comments," or "denial." DSE workers were defined participants who answered "yes."

The question about sleep quality consisted of the following; 1) difficulty falling asleep, 2) difficulty maintaining sleep, and 3) extreme fatigue after waking up. The answers included "every day," "several time a week," "several times a month," "rarely," "none," "no comments," or "denial." The workers were considered to have poor sleep quality for each part if there were disturbances several times in a month at least.

The covariates were based on general, occupational, and hazardous factors. The general factors included sex, age, and monthly income. Age was classified into below 40, 40–49,



**Fig. 1.** Study participants selection. KWCS: Korean Working Conditions Survey.

50–59, and greater or equal to 60 groups. Monthly income was classified as less than 2 million Korean Won (KRW), 2 million to less than 3 million KRW, 3 million to less than 4 million KRW, and greater or equal to 4 million KRW. The occupational factors included job categorization, working hours per week, and shift work. The job categorization consisted of 3 groups: white-collar, yellow-collar, and blue-collar workers. Managers, professionals and related workers, and office workers were classified as white-collar workers. Yellow-collar workers were defined in the job of service and sales, while skilled agricultural, forestry and fishery workers, technicians and related workers, equipment and machinery operators, and assembly workers were classified as blue-collar workers. The working hours per week was divided into 2 groups based on a cut off value of 52 hours per week, which represents 30% exceed of legal working hours as 40 hours. Exposure to physical factor and emotional labor was classified as hazardous factors. Exposure to physical factors was defined as exposure to at least one of the following for more than a quarter of the working hours: vibration, noise, high temperature, and low temperature. Emotional labor was defined as workers dealing with customers, passengers, students, or patients with anger for more than a quarter of working hours.

### Statistical analysis

A  $\chi^2$  test was performed to compare the characteristics of DSE according to sleep quality. A multiple logistic regression analysis was performed to analyze the relationship between DSE and sleep quality, and other logistic regression analyses were performed with the other variables of general, occupational, and hazardous factors for sleep quality in DSE to investigate the relative risk of other variables. All statistical analyses were performed using SPSS version 23.0 (SPSS Inc., Chicago, IL, USA).

### Ethics statement

This study was approved by the Institutional Review Board (IRB) of Gachon University Gil Medical Center (approval No. GFIRB2019-278).

## RESULTS

A total of 2,287 (6.2%) participants were included in the DSE group. Characteristics based on the distribution of DSE showed that the number of women were more than that of men, and under the age of 40 years was the most in age distribution. Yellow-collar workers were the largest group based on occupation, and mostly spent 52 hours or less per week for working. Shift workers on DSE were less comparing to those on non-DSE. For hazardous factors, workers in DSE were less exposed to physical factors while most of them were exposed to emotional factors. For the sleep quality, a total of 4,220 (11.5%) out of 36,709 participants had problems with falling asleep, 3,880 (10.6%) participants had problems with maintaining sleep, and 4,732 (12.9%) had extreme fatigue after waking up. Statistical significance was found on difficulty falling asleep, difficulty maintaining sleep, and extreme fatigue after waking up according to the DSE status (**Table 1**).

Non-DSE workers were considered as the reference group for each sleep complaint, and multiple logistic regression analysis was performed (**Table 2**). For all sleep complaints, sex, age, monthly income, occupational classification, working hours per week, shiftwork, exposure to physical factors and emotional labor were adjusted. Difficulty falling asleep was associated with DSE comparing to non-DSE (odds ratio [OR]: 1.331, 95% confidence interval [CI]: 1.178–1.504), and difficulty maintaining sleep was associated with DSE comparing

## Dependent self-employment workers and sleep quality

**Table 1.** General characteristics of participants based on dependent self-employment

Characteristics	Total	Dependent self-employment		p-value
		Yes	No	
Total	36,709 (100.0)	2,287 (6.2)	34,422 (93.8)	
Sex				< 0.001
Male	20,792 (56.6)	1,110 (48.5)	19,682 (57.2)	
Female	15,917 (43.4)	1,177 (51.5)	14,740 (42.8)	
Age (years)				< 0.001
< 40	15,932 (43.4)	797 (34.8)	15,135 (44.0)	
40–49	9,284 (25.3)	627 (27.4)	8,657 (25.1)	
50–59	7,382 (20.1)	605 (26.4)	6,777 (19.7)	
≥ 60	4,113 (11.2)	259 (11.3)	3,854 (11.2)	
Monthly income (10,000 won)				< 0.001
< 200	12,406 (33.8)	648 (28.3)	11,758 (34.2)	
200–300	10,473 (28.5)	773 (33.8)	9,700 (28.2)	
300–400	7,734 (21.1)	536 (23.4)	7,198 (20.9)	
≥ 400	6,096 (16.6)	330 (14.4)	5,766 (16.8)	
Occupational classification				< 0.001
White-collar	17,072 (46.5)	539 (23.6)	16,533 (48.0)	
Yellow-collar	8,830 (24.1)	1,197 (52.3)	7,633 (22.2)	
Blue-collar	10,808 (29.4)	552 (24.1)	10,256 (29.8)	
Working hours per week (> 52 hours)				< 0.001
No	31,959 (87.1)	1,874 (81.9)	30,085 (87.4)	
Yes	4,750 (12.9)	413 (18.1)	4,337 (12.6)	
Shift work				< 0.001
No	32,367 (88.2)	2,125 (92.9)	30,242 (87.9)	
Yes	4,340 (11.8)	162 (7.1)	4,180 (12.1)	
Exposure to physical factors				0.346
No	23,329 (63.5)	1,475 (64.5)	21,854 (63.5)	
Yes	13,381 (36.5)	813 (35.5)	12,568 (36.5)	
Emotional labor				< 0.001
No	15,986 (43.5)	424 (18.5)	15,562 (45.2)	
Yes	20,723 (56.5)	1,863 (81.5)	18,860 (54.8)	
Difficulty falling asleep				< 0.001
No	32,489 (88.5)	1,933 (84.5)	30,556 (88.8)	
Yes	4,220 (11.5)	354 (15.5)	3,866 (11.2)	
Difficulty maintaining sleep				< 0.001
No	32,831 (89.4)	1,976 (86.4)	30,855 (89.6)	
Yes	3,880 (10.6)	312 (13.6)	3,568 (10.4)	
Extreme fatigue after waking up				< 0.001
No	31,977 (87.1)	1,888 (82.6)	30,089 (87.4)	
Yes	4,732 (12.9)	399 (17.4)	4,333 (12.6)	

Values are presented as number (%).

to non-DSE (OR: 1.279, 95% CI: 1.125–1.455). Extreme fatigue after waking up was also associated with DSE (OR: 1.331, 95% CI: 1.184–1.496).

To find out specific characteristics of other variables, multiple logistic regression analyses were performed for the DSE group (Table 3). Less or equal to 40 years of age was significantly associated with difficulty falling asleep when compared to greater or equal to 40 years of age (OR: 0.613, 95% CI: 0.389–0.965), and exposure to physical factors was also significantly associated with difficulty falling asleep when compared to non-exposure group of that (OR: 1.474, 95% CI: 1.51–1.886). White-collar workers were significantly associated with difficulty maintaining sleep when compared to blue-collar workers (OR: 0.661, 95% CI: 0.454–0.964). The groups of shiftwork (OR: 1.703, 95% CI: 1.122–2.584) and exposure to physical factors (OR: 1.781, 95% CI: 1.379–2.301) were also significantly associated with difficulty maintaining sleep when compared to the other group. For extreme fatigue after waking up, a statistical significance was found for 40–49 years of age (OR: 1.397, 95% CI: 1.045–1.866)

## Dependent self-employment workers and sleep quality

**Table 2.** ORs of dependent self-employment associated with sleep quality

Variables	Difficulty falling asleep			Difficulty maintaining sleep			Extreme fatigue after waking up		
	OR	CI	p-value	OR	CI	p-value	OR	CI	p-value
Dependent self-employment									
No	Ref.			Ref.			Ref.		
Yes	1.331	1.178–1.504	< 0.001	1.279	1.125–1.455	< 0.001	1.331	1.184–1.496	< 0.001
Sex (female)									
Male	Ref.			Ref.			Ref.		
Female	1.109	1.026–1.199	0.009	1.245	1.147–1.350	< 0.001	1.180	1.095–1.272	< 0.001
Age (years)									
< 40	Ref.			Ref.			Ref.		
40–49	1.045	0.960–1.138	0.305	1.143	1.046–1.249	0.003	1.103	1.017–1.195	0.017
50–59	1.164	1.064–1.274	0.001	1.296	1.180–1.423	< 0.001	1.151	1.056–1.255	0.001
≥ 60	1.219	1.088–1.367	0.001	1.454	1.295–1.631	< 0.001	1.177	1.056–1.312	0.003
Monthly income (10,000 won)									
< 200	Ref.			Ref.			Ref.		
200–300	0.807	0.740–0.880	< 0.001	0.832	0.760–0.911	< 0.001	0.915	0.841–0.994	0.036
300–400	0.775	0.698–0.861	< 0.001	0.766	0.686–0.856	< 0.001	0.930	0.842–1.028	0.154
≥ 400	0.892	0.795–1.002	0.053	1.011	0.898–1.138	0.858	1.058	0.947–1.182	0.315
Occupational classification									
White-collar	Ref.			Ref.			Ref.		
Yellow-collar	0.947	0.867–1.035	0.231	0.824	0.750–0.906	< 0.001	0.924	0.847–1.008	0.074
Blue-collar	0.825	0.749–0.908	< 0.001	0.853	0.773–0.942	0.002	1.025	0.936–1.121	0.597
Working hours per week (> 52 hours)									
No	Ref.			Ref.			Ref.		
Yes	1.219	1.110–1.339	< 0.001	1.387	1.261–1.524	< 0.001	1.471	1.350–1.602	< 0.001
Shift work									
No	Ref.			Ref.			Ref.		
Yes	1.261	1.146–1.386	< 0.001	1.210	1.095–1.336	< 0.001	1.266	1.157–1.385	< 0.001
Exposure to physical factors									
No	Ref.			Ref.			Ref.		
Yes	1.398	1.302–1.501	< 0.001	1.702	1.582–1.831	< 0.001	1.836	1.717–1.964	< 0.001
Emotional labor									
No	Ref.			Ref.			Ref.		
Yes	1.465	1.361–1.576	< 0.001	1.438	1.333–1.550	< 0.001	1.564	1.459–1.678	< 0.001

Statistical estimated from a multivariate logistic model that adjusted for all other covariates excluding an interesting variant.

OR: odds ration; CI: confidence interval.

when compared to less than 40 years of age. Monthly income greater or equal to 4 million KRW was also significantly associated with extreme fatigue after waking up when compared to less than 2 million KRW (OR: 1.636, 95% CI: 1.159–2.309). Greater than 52 hours of working hours per week (OR: 1.603, 95% CI: 1.232–2.086), shiftwork (OR: 1.604, 95% CI: 1.096–2.346), exposure to physical factors (OR: 2.234, 95% CI: 1.784–2.798), and emotional labor (OR: 1.373, 95% CI: 1.019–1.850) were also associated with extreme fatigue after waking up when compared to the other groups.

## DISCUSSION

This study examined the relationship between DSE and sleep quality based on the fifth KWCS. Workers in DSE have higher relative risks for all 3 parts of sleep quality; difficulty in falling asleep (OR: 1.331), difficulty in maintaining sleep (OR: 1.279), and extreme fatigue after waking up (OR: 1.331). The results show that DSE may affect the sleep quality, and workers in DSE may have problems of hyperarousal and sleep hygiene.

## Dependent self-employment workers and sleep quality

**Table 3.** ORs of variables associated with sleep quality in a group of dependent self-employment

Variables	Difficulty falling asleep			Difficulty maintaining sleep			Extreme fatigue after waking up		
	OR	CI	p-value	OR	CI	p-value	OR	CI	p-value
Sex (female)									
Male	Ref.			Ref.			Ref.		
Female	0.917	0.699–1.203	0.533	1.262	0.971–1.641	0.082	1.051	0.806–1.371	0.713
Age (years)									
< 40	Ref.			Ref.			Ref.		
40–49	0.816	0.606–1.100	0.182	0.825	0.595–1.145	0.250	1.397	1.045–1.866	0.024
50–59	0.874	0.647–1.181	0.381	1.070	0.780–1.468	0.676	1.186	0.877–1.603	0.268
≥ 60	0.613	0.389–0.965	0.034	1.088	0.709–1.671	0.699	1.181	0.787–1.771	0.422
Monthly income (10,000 won)									
< 200	Ref.			Ref.			Ref.		
200–300	0.811	0.595–1.106	0.186	0.828	0.601–1.140	0.247	0.990	0.739–1.328	0.948
300–400	0.855	0.603–1.214	0.383	0.947	0.658–1.365	0.771	1.217	0.892–1.662	0.216
≥ 400	1.402	0.956–2.055	0.083	1.208	0.798–1.828	0.371	1.636	1.159–2.309	0.005
Occupational classification									
White-collar	Ref.			Ref.			Ref.		
Yellow-collar	1.102	0.824–1.472	0.514	0.870	0.646–1.172	0.360	0.867	0.651–1.155	0.329
Blue-collar	0.816	0.549–1.213	0.315	0.661	0.454–0.964	0.032	0.806	0.558–1.164	0.250
Working hours per week (> 52 hours)									
No	Ref.			Ref.			Ref.		
Yes	1.203	0.887–1.632	0.235	1.357	0.993–1.855	0.055	1.603	1.232–2.086	< 0.001
Shift work									
No	Ref.			Ref.			Ref.		
Yes	1.023	0.649–1.613	0.922	1.703	1.122–2.584	0.012	1.604	1.096–2.346	0.015
Exposure to physical factors									
No	Ref.			Ref.			Ref.		
Yes	1.474	1.151–1.886	0.002	1.781	1.379–2.301	< 0.001	2.234	1.784–2.798	< 0.001
Emotional labor									
No	Ref.			Ref.			Ref.		
Yes	1.132	0.822–1.557	0.448	1.012	0.729–1.404	0.944	1.373	1.019–1.850	0.037

Statistical estimated from a multivariate logistic model that adjusted for all other covariates excluding an interesting variant.

OR: odds ration; CI: confidence interval.

Workers in DSE have more physical and psychological stress than those in standard employment due to low wages, long working hours, irregular schedules, and insecure employments. This stress of workers in DSE causes the poor sleep quality due to hyperarousal and poor sleep hygiene. Abnormal stimuli such as sensory stimuli or information processing including stress cause alertness. The alertness increases pre-sleep hyperarousal [11], and may induce sleep latency [12]. Sleep hygiene, defined as behavioral and environmental conditions for sleep, also has a key role in sleep quality [13]. The risk factors affecting sleep hygiene are as follows: caffeine, nicotine, alcohol, noise, stress, and irregular sleep [11]. Since workers in DSE have irregular sleep, it changes the circadian rhythm, which may result sleep disorders [14]. A circadian rhythm is essential to regulate sleep-wake cycle as well as melatonin secretion. Irregular sleep-wake schedules cause irregular exposure to those factors, and circadian rhythms can also be broken [15]. Workers in DSE may be weak at sleep maintenance since the circadian rhythm can be easily broken.

The overall working conditions of DSE are related to sleep quality. Poor sleep quality induces daytime sleepiness and fatigue [16]. In a study by the EWCS, employment insecurity had a relative risk of 47% for sleep disturbance [17]. More importantly, poor quality of sleep may cause a decrease in concentration at work and work performance [18]. In another study, a meta-analysis of sleep disorders and daytime cognitive performance showed significant impairments of episodic memory with manipulating disorders and retention as well as decreased ability of problem solving [19]. As the risk for sleep disorder increases negative

work outcomes, it may cause occupational accidents [20]. A high injury rate was also associated with employment insecurity. A report by the ILO showed that NSE has higher injury rate [1], and another study by Giraudo et al. [21] showed an association between injury risk and precarious work.

In the characteristics of other factors among workers in DSE, exposure to physical factors was found as a higher relative risk factor for all 3 components of sleep quality. Exposure to physical factors included noise, vibration, hot and cold temperature. Noise and vibration usually disturb sleep immediately after exposure, but the sleep quality may be affected by exposure to noise in daytime. Fruhstorfer et al. [22] reported that daytime noise increased the slow wave sleep with decrease in stage 2 sleep at night sleep. A study by Gitanjali and Ananth [23] also showed that the sleep efficacy was less than 80% after exposure to daytime noise as well as rapid eye movement (REM) sleep, slow wave sleep, and REM onset latency were decreased. Exposure to heat and cold at workplace was also related to sleep disorder. Underground miners, who were usually exposed to heat, complained of sleep disorder, fatigue, and cognitive impairment [24]. This might be related to melatonin, which is the endogenous hormone playing a key role in thermoregulatory function as well as circadian rhythm. Melatonin induces vasodilatation in cutaneous vessels during sleep to reduce the core body temperature [25]. If the core body temperature elevates, melatonin levels increase to make the core body temperature lower [26], and it can be occurred conversely in cold exposure [27]. External environment may cause the changes in sleep quality by controlling of melatonin secretion.

The other risk factor found in the group of workers in DSE was shiftwork. Frequent work shift causes cognitive impairment or low work performance [28]. It is difficult for shift workers to modify circadian rhythm, so the prevalence of poor sleep quality in shift workers was 30.7% compared to 19.2% of all the workers according to a study by the National Health and Nutrition Examination Survey in the US [29]. In this study, shift workers in DSE showed higher relative risk in sleep quality than the others. It is necessary to look closely the sleep quality of shift workers in DSE.

Workers in DSE may complain of poor sleep quality as an initial symptom of anxiety and depression due to stress and employment insecurity. At the same time, it is necessary to recognize the sleep quality of workers in DSE as their mental health. Thus, further studies are necessary to determine the interaction between DSE and psychiatric disorders such as depression, anxiety, and sleep disorder.

There are several strengths in the study. Only few studies exist about the relationship between DSE and sleep quality. Unlike traditional NSE such as temporary or part-time work, there are a few studies on health effects of DSE. The results may be used as a basis for future studies on sleep quality of workers in DSE. The study also included specific components of sleep quality: sleep initiation, maintenance, and fatigue. The study was also able to determine high-risk factors related to poor sleep quality in DSE like exposure to physical factors and shiftwork.

This study has several limitations. It is difficult to determine the causal relationship of poor sleep quality of workers in DSE since this was a cross-sectional study based on the KWCS. The KWCS is also based on a self-administered survey questionnaire. Therefore, there might exist missing questions or inappropriate answers to questions. This may affect the statistical results as possibly under- or over-estimated. However, well-trained interviewer helped the

responders to answer properly, so this error seems to be minimal. Finally, there was no social or medical history. The KWCS does not provide the information on social habits such as smoking, alcohol, and caffeine intakes and the history of mental disorders.

## CONCLUSIONS

DSE is associated with a risk of poor sleep quality. Due to employment insecurity and stress, workers in DSE are vulnerable to poor sleep quality. Among the workers in DES, poor sleep quality is related to shiftwork and exposure to physical factors such as noise, vibration, and abnormal temperature. Poor sleep quality may affect mental health and occupational injuries, so it is necessary to monitor the sleep quality of workers in DSE.

## REFERENCES

1. International Labour Office. Non-standard employment around the world: understanding challenges, shaping prospects. Geneva: International Labour Office; 2016.
2. International Labour Organization. Non-standard forms of employment: report for discussion at the meeting of experts on non-standard forms of employment. Geneva: International Labour Organization; 2015.
3. Quinlan M. The effects of non-standard forms of employment on worker health and safety. Geneva: International Labour Office; 2015.
4. Kim IH, Muntaner C, Khang YH, Paek D, Cho SI. The relationship between nonstandard working and mental health in a representative sample of the South Korean population. *Soc Sci Med* 2006;63(3):566-74.  
[PUBMED](#) | [CROSSREF](#)
5. Williams CC, Lapeyre F. Dependent self-employment: trends, challenges and policy responses in the EU. Geneva: International Labour Organization; 2017.
6. Seon JJ, Lim YJ, Lee HW, Yoon JM, Kim SJ, Choi S, et al. Cardiovascular health status between standard and nonstandard workers in Korea. *PLoS One* 2017;12(6):e0178395.  
[PUBMED](#) | [CROSSREF](#)
7. Ahn J, Kim NS, Lee BK, Park J, Kim Y. Non-standard workers have poorer physical and mental health than standard workers. *J Occup Environ Med* 2019;61(10):e413-21.  
[PUBMED](#) | [CROSSREF](#)
8. Williams CC, Horodnic IA. Evaluating the prevalence and distribution of dependent self-employment: some lessons from the European Working Conditions Survey. *Ind Relat J* 2018;49(2):109-27.  
[CROSSREF](#)
9. Kim YS, Rhee KY, Oh MJ, Park J. The validity and reliability of the second Korean working conditions survey. *Saf Health Work* 2013;4(2):111-6.  
[PUBMED](#) | [CROSSREF](#)
10. Seo HJ. Development of a tailored analysis system for Korean working conditions survey. *Saf Health Work* 2016;7(3):201-7.  
[PUBMED](#) | [CROSSREF](#)
11. Irish LA, Kline CE, Gunn HE, Buysse DJ, Hall MH. The role of sleep hygiene in promoting public health: a review of empirical evidence. *Sleep Med Rev* 2015;22:23-36.  
[PUBMED](#) | [CROSSREF](#)
12. Drake C, Richardson G, Roehrs T, Scofield H, Roth T. Vulnerability to stress-related sleep disturbance and hyperarousal. *Sleep* 2004;27(2):285-91.  
[PUBMED](#) | [CROSSREF](#)
13. Suen LK, Tam WW, Hon KL. Association of sleep hygiene-related factors and sleep quality among university students in Hong Kong. *Hong Kong Med J* 2010;16(3):180-5.  
[PUBMED](#)
14. Zee PC, Vitiello MV. Circadian rhythm sleep disorder: irregular sleep wake rhythm type. *Sleep Med Clin* 2009;4(2):213-8.  
[PUBMED](#) | [CROSSREF](#)
15. Lu BS, Zee PC. Circadian rhythm sleep disorders. *Chest* 2006;130(6):1915-23.  
[PUBMED](#) | [CROSSREF](#)

16. Kang JH, Chen SC. Effects of an irregular bedtime schedule on sleep quality, daytime sleepiness, and fatigue among university students in Taiwan. *BMC Public Health* 2009;9(1):248.  
[PUBMED](#) | [CROSSREF](#)
17. Mai QD, Hill TD, Vila-Henninger L, Grandner MA. Employment insecurity and sleep disturbance: evidence from 31 European countries. *J Sleep Res* 2019;28(1):e12763.  
[PUBMED](#) | [CROSSREF](#)
18. Costa G. Shift work and health: current problems and preventive actions. *Saf Health Work* 2010;1(2):112-23.  
[PUBMED](#) | [CROSSREF](#)
19. Fortier-Brochu E, Beaulieu-Bonneau S, Ivers H, Morin CM. Insomnia and daytime cognitive performance: a meta-analysis. *Sleep Med Rev* 2012;16(1):83-94.  
[PUBMED](#) | [CROSSREF](#)
20. Swanson LM, Arnedt JT, Rosekind MR, Belenky G, Balkin TJ, Drake C. Sleep disorders and work performance: findings from the 2008 National Sleep Foundation Sleep in America poll. *J Sleep Res* 2011;20(3):487-94.  
[PUBMED](#) | [CROSSREF](#)
21. Giraudo M, Bena A, Leombruni R, Costa G. Occupational injuries in times of labour market flexibility: the different stories of employment-secure and precarious workers. *BMC Public Health* 2016;16(1):150.  
[PUBMED](#) | [CROSSREF](#)
22. Fruhstorfer B, Fruhstorfer H, Grass P. Daytime noise and subsequent night sleep in man. *Eur J Appl Physiol Occup Physiol* 1984;53(2):159-63.  
[PUBMED](#) | [CROSSREF](#)
23. Gitanjali B, Ananth R. Effect of acute exposure to loud occupational noise during daytime on the nocturnal sleep architecture, heart rate, and cortisol secretion in healthy volunteers. *J Occup Health* 2003;45(3):146-52.  
[PUBMED](#) | [CROSSREF](#)
24. Legault G. Sleep and heat related changes in the cognitive performance of underground miners: a possible health and safety concern. *Minerals (Basel)* 2011;1(1):49-72.  
[CROSSREF](#)
25. Cagnacci A, Elliott JA, Yen SS. Melatonin: a major regulator of the circadian rhythm of core temperature in humans. *J Clin Endocrinol Metab* 1992;75(2):447-52.  
[PUBMED](#)
26. Aoki K, Stephens DP, Zhao K, Kosiba WA, Johnson JM. Modification of cutaneous vasodilator response to heat stress by daytime exogenous melatonin administration. *Am J Physiol Regul Integr Comp Physiol* 2006;291(3):R619-24.  
[PUBMED](#) | [CROSSREF](#)
27. Ishibashi K, Arikura S, Kozaki T, Higuchi S, Yasukouchi A. Thermoregulatory effect in humans of suppressed endogenous melatonin by pre-sleep bright-light exposure in a cold environment. *Chronobiol Int* 2010;27(4):782-806.  
[PUBMED](#) | [CROSSREF](#)
28. Kazemi R, Motamedzade M, Golmohammadi R, Mokarami H, Hemmatjo R, Heidarimoghadam R. Field study of effects of night shifts on cognitive performance, salivary melatonin, and sleep. *Saf Health Work* 2018;9(2):203-9.  
[PUBMED](#) | [CROSSREF](#)
29. Yong LC, Li J, Calvert GM. Sleep-related problems in the US working population: prevalence and association with shiftwork status. *Occup Environ Med* 2017;74(2):93-104.  
[PUBMED](#) | [CROSSREF](#)