



Contents lists available at ScienceDirect

# Safety and Health at Work

journal homepage: [www.e-shaw.net](http://www.e-shaw.net)

## Original article

# Association between Work-related Communication Devices Use during Work Outside of Regular Working Hours and Depressive Symptoms in Wage Workers

Min-Sun Kim<sup>1</sup>, Shin-Goo Park<sup>1,\*</sup>, Hwan-Cheol Kim<sup>1</sup>, Sang-Hee Hwang<sup>2</sup>

<sup>1</sup> Department of Occupational and Environmental Medicine, Inha University Hospital, Incheon, Republic of Korea

<sup>2</sup> Department of Dentistry, Keimyung University School of Medicine, Dalseo-Gu, Daegu, Republic of Korea

## ARTICLE INFO

### Article history:

Received 3 October 2022  
Received in revised form  
13 November 2023  
Accepted 20 November 2023  
Available online 23 November 2023

### Keywords:

communication devices  
depressive symptoms  
wage worker  
working hours

## ABSTRACT

**Background:** This study aimed to investigate the relationship between work-related communication devices use during work outside of regular working hours and depressive symptoms in wage workers. **Methods:** Data from 50,538 workers aged 15 years or older who had participated in the 6th Korean Working Condition Survey (KWCS) were used. The final sample was 32,994 wage workers. The questionnaire asked the respondents how often they used communication devices for work during work outside of regular working hours. Depressive symptoms were assessed using WHO-5 Well-Being Index. Multiple logistic regression analysis was used to analyze the association between work-related communication devices use during work outside of regular working hours and depressive symptoms. **Results:** The rate of depressive symptoms was highest among workers who did not use work-related communication devices during work outside of regular working hours. After adjusting for socio-demographic and work-related factors, the odds ratio of depressive symptoms among workers who used communication devices when working outside of regular working hours was 1.20 (95% CI: 1.09–1.32); the odds ratio of depressive symptoms in the group not using communication devices for free-time work was 1.66 (95% CI: 1.37–2.00), which was higher than that of the reference group, that is, workers who did not work outside of regular working hours, and was statistically significant. **Conclusion:** Regardless of whether work-related communication devices are used, working outside of regular working hours increases depressive symptoms. The use of work-related communication devices during work outside of regular working hours can reduce the rate of depressive symptoms.

© 2023 Occupational Safety and Health Research Institute. Published by Elsevier B.V. on behalf of Institute, Occupational Safety and Health Research Institute, Korea Occupational Safety and Health Agency. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

According to the World Health Organization (WHO), the prevalence of depression in the global population is estimated to be 4.4%, and the total estimated population living with depression over 10 years has increased by 18.4% [1,2]. A study in 2000 found that the prevalence of depression in 30 countries was 7.2% for 1-year prevalence and 10.8% for lifetime prevalence [3]. According to the 2021 Mental Health Survey report in Republic of Korea, the lifetime prevalence of depression was 7.7% and the 1-year

prevalence was 1.7%, which increased from the 2016 Mental Health Survey, which had a lifetime prevalence of 5.0% and a 1-year prevalence of 1.5%.

The rate of depression among mental disorders at work is 6.9%–16.2%, accompanied by decreased physical function and motivation, resulting in significantly low work performance and loss of working days [4–8]. Depressed workers are likely to be unable to concentrate on their work or be exposed to accidents. Depression causes economic loss through reduced work productivity and has an overall adverse effect on society [9,10].

Min-Sun Kim: <https://orcid.org/0000-0001-7121-7555>; Shin-Goo Park: <https://orcid.org/0000-0002-1544-4486>; Hwan-Cheol Kim: <https://orcid.org/0000-0002-3635-1297>; Sang-Hee Hwang: <https://orcid.org/0000-0001-9486-9214>

\* Corresponding author. Department of Occupational and Environmental Medicine, School of Medicine, Inha University Hospital, 7-206 3rd Street Shinhung-dong, Jung-gu, Incheon, 400-711, Republic of Korea.

E-mail address: [stressdr@naver.com](mailto:stressdr@naver.com) (S.-G. Park).

The work environment of workers can play an important role in the mental health of workers [11,12]. Regarding mental health, several occupational factors have been suggested, such as shift work, working hours, working environment, job satisfaction, and job stress [13–16]. Among the characteristics of workers' working environment, various work schedules were suggested as the cause of depression [17–21]. In previous studies, not only did workers exhibit an increased risk of developing depression when working long hours but also increased symptoms of depression during irregular and unpredictable work schedules [22]. Therefore, there is growing interest in the impact of unpredictable overtime on workers' mental health [23]. Working outside of regular working hours is when you work at unscheduled or unexpected hours, including before you arrive at work, before official business hours, during your lunch break, after work, or on holidays. The irregular and unpredictable work schedules are one feature of non-standard or precarious work that accounts for up to 25%–40% of the workforce in many developed countries [24,25].

Recent developments in communication technology have transformed the work environment [26]. Following this trend, many workers use work-related communication devices during work outside of regular working hours. According to a study conducted by the Republic of Korea Labor Institute in 2015 on 2,402 wage earners, 70.3% of workers answered that they use work-related communication devices during work outside of regular working hours [27]. Workers can access work anytime and anywhere through communication devices (e.g., phone calls, text messages, emails, video conferences, and applications) [28]. Such easy accessibility through communication devices provides workers with the flexibility and autonomy to work outside the office or even after working hours, which has a positive impact on workers' mental health by promoting work-life balance and reducing emotional fatigue [29–31]. In addition, owing to the development of communication technology, the working environment is changing in the form of increasing the use of communication devices for workers' work during working hours and after traditional working hours [32]. When working free hours outside of regular working hours, it is possible to handle work outside the company by using communication devices for work, increasing flexibility of work. Workers are now able to handle their work outside of home or work.

Many studies have shown that long working hours adversely affect workers' health, and irregular and unpredictable working hours adversely affect the health of non-regular workers [33]. However, few studies have investigated the health effects of working work outside of regular working hours among wage workers.

Therefore, this study aims to find out the relationship between working outside of regular working hours and depressive symptoms in Korean wage workers. In addition, the purpose of this study was to investigate the relationship between the use of work-related

communication devices during work outside of regular working hours and depressive symptoms.

## 2. Materials and methods

### 2.1. Data source and study population

#### 2.1.1. Data source

This study is a secondary analysis study using data from the Sixth Korean Working Conditions Survey (6th KWCS) conducted from October 2020 to April 2021. The KWCS is a representative cross-sectional design survey conducted in Republic of Korea, and data are collected every three years by the Occupational Safety and Health Research Institute (OSHRI) in Republic of Korea. The KWCS questionnaire was initially developed based on the original questionnaire from the European Working Conditions Survey (EWCS) conducted by Eurofound, an affiliate of the European Union (EU) [34]. In the 6th KWCS survey from October 2020 to April 2021, a specially trained interviewer visited each household and conducted a 1:1 interview using an electronic questionnaire mounted on a tablet PC. However, from December 2020 to January 2021, face-to-face surveys were difficult due to the government's strengthened quarantine measures following the spread of COVID-19, so instead of on-site surveys, self-written recruitment surveys through paper surveys and non-face-to-face online surveys were conducted in parallel.

In this study, we used a layered random-sample design. All data in KWCS were weighted by applying the raking ratio method using the results of the '2020 Economically Active Population Survey' of the National Statistical Office. The raking ratio method is a method proposed by Deming and Stephan (1940) to ensure consistency between population data and sample survey data, and is a method that matches population distribution information while repeatedly adjusting each cell value on a multidimensional classification table [35].

#### 2.1.2. Study population

A total of 50,538 workers aged  $\geq 15$  years participated in the 2020 KWCS. The following individuals were excluded: 15,870 self-employed individuals; 1,605 unpaid family workers; and 69 people who did not respond or refused to respond. Therefore, the final study sample consisted of 32,994 wage workers who worked for more than one hour over the past one week and were paid salary, daily wages, spot goods, lodging, and so on (Fig. 1).

### 2.2. Depressive symptoms

Depressive symptoms were evaluated using the WHO 5-item Well-Being Index (WHO-5), a screening tool for depression and mental health diagnoses. The WHO-5 is an excellent indicator of depression and overall emotional function, covering a variety of emotions, including positive emotions (feeling good or calm) and

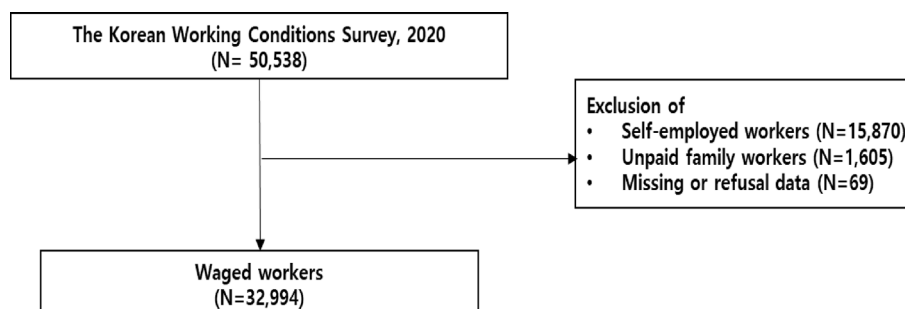


Fig. 1. A flow chart illustrating the process of creating the study population (N, weighted frequency).

well-being (feeling physically active and refreshed in the morning). Depression screening criteria were based on the 50% cut-off applied in previous studies [36].

The WHO-5 consists of five items.

1. I have felt cheerful and in good spirits.
2. I have felt calm and relaxed.
3. I have felt active and vigorous.
4. I woke up feeling fresh and rested.
5. My daily life has been filled with things that interest me.

Respondents were asked how often they experienced the feelings mentioned in the above five items in the past two weeks. The questions were rated on a 6-point Likert scale. (always = 1 [score 5 points], most of the time = 2 [score 4 points], more than half of 2 weeks = 3 [score 3 points], less than half of 2 weeks = 4 [score 2 points], sometimes = 5 [score 1], never = 6 [score 0]).

The sum of the scores ranges from 0 to 25, which is multiplied by 4 to convert to a weighted score between 0 and 100. A weighted score of 28 or less indicates a depressive state requiring treatment, and a score of 29–50 indicates depressive symptoms. In this study, subjects with a weighted score of 51–100 were classified as the control group, and the 0–50 range was classified as the depressed group with depressive symptoms [36].

### 2.3. Working outside of regular working hours and using work-related communication devices

In this study, the participants were selected using two questions. The first question was, “How often have you worked in the past year (less than a year since you started your main job) outside of regular working hours?”. Working outside of regular working hours refers to personal time that the individual is entitled to spend on personal chores, rest, hobbies, etc. Working outside of regular working hours refers to working outside the workplace and not during official working days, working hours, and officially mandated overtime. There were five possible responses: every day, several times a week, several times a month, rarely, and never. Workers who answered that they worked daily, several times a week, and several times a month were selected as those who worked outside of regular working hours.

The second question was, “How often did you use work-related communication devices during work outside of regular working hours last month?”. Communication devices include devices used for e-mail, telephone and video conferencing, text messaging, social media, and other online activities. Tasks include responding to requests, checking emails, etc. There were five possible responses: every day, several times a week, several times a month, rarely, and never. Those who reported working daily, several times a week, or several times a month were classified as workers who used communication devices for work during work outside of regular working hours.

### 2.4. Other covariants

Other covariants related to depressive symptoms included socio-demographic factors (gender, age, and education) and work-related factors (monthly income, work hours per week, working period, employment type, and occupation group). These variables were included as covariates in the logistic regression analysis, and a subgroup analysis of these variables was performed. Their ages were classified as under 29, 30–39, 40–49, 50–59, and 60 years or older. Education level was classified into three categories: middle school or lower, high school, and college or higher. Monthly income was divided into less than 2 million won, 2–2.9 million won, 3–

3.99 million won, and 4 million won or more. Employment types were divided into regular, temporary, and daily workers, and working hours per week were classified into three groups based on 40–52 hours per week. In Republic of Korea, according to the Labor Standards Act, working hours per week cannot exceed 40 hours, excluding breaks, and overtime work is limited to a maximum of 12 hours per week, with a maximum of 52 hours per week. The working period was divided into three groups: less than one year, one–five years, and more than five years. Working hours were divided into full-time and part-time, and the presence or absence of shift work was included. Occupations were classified according to the Korean Standard Occupation Classification, and the nine occupational categories were divided into three groups: white-collar workers (e.g., managers, professionals, and clerks), pink-collar workers (e.g., service and sales workers), and blue-collar workers (e.g., craft and trade workers, machinery drivers, and assembly workers).

### 2.5. Statistical analysis

To analyze the study participants, the relationship between the general characteristics of wage workers and depressive symptoms was analyzed using a  $\chi^2$  test. Next, the analysis was conducted in three groups: those who did not work outside of regular working hours, those who used work-related communication devices during work outside of regular working hours, and those who did not use work-related communication devices during work outside of regular working hours. Logistic regression analysis was conducted to analyze the relationship between the use of work-related communication devices and depressive symptoms during work outside of regular working hours, adjusting for the statistically significant factor with the control variable (covariance). All analyses were performed using IBM SPSS Statistics for Windows version 25. A  $p$  value < 0.05 were considered significant.

## 3. Results

Table 1 showed the relationship between the general characteristics of wage workers and depressive symptoms, according to the WHO-5. In the analysis by age, the proportion of depressive symptoms increased proportionally with age, and the proportion of depressive symptoms in the 60 and above age group was high (for ages  $\leq 29$ , 30–39, 40–49, 50–59, and  $> 60$  years, depressive symptoms  $p < 0.001$ , 24.7%, 29.9%, 33.2%, and 41.9%, respectively). Workers who worked less than 40 hours or more than 52 hours per week had high rates of depression symptoms (for  $< 40$  h, 40–52 h, and  $> 52$  h, respectively, depressive symptoms  $p < 0.001$ , 37.9%, 28.7%, and 38.6%). As for the working period, 2,025 (35.5%) who had worked for less than a year and 4,298 (38.8%) of the blue-collar workers among the occupational groups showed high rates of depressive symptoms. Among workers who used communication devices for work during work outside of regular working hours, 785 (32.9%) had depressive symptoms and those who did not use communication devices for work during work outside of regular working hours, 211 (42.4%) had depressive symptoms.

Next, an analysis was conducted to find out the relationship between working outside of regular working hours and depressive symptoms and the association between work-related communication devices use during work outside of regular working hours and depressive symptoms. To analyze the difference in the relevance of developing depressive symptoms between working outside of regular working hours and work-related communication devices use, a logistic regression analysis was performed (Table 2). In the model adjusted for socio-demographic and work-related factors, when comparing the group that did not work outside of regular working

**Table 1**  
The prevalence of depressive symptoms by characteristics of participants

Variables	Total	Participants [N (%)]		p
		No depressive symptom	Depressive symptom	
Sex				0.448
Male	15,467	10,589 (68.5%)	4,878 (31.5%)	
Female	17,527	11,931 (68.1%)	5,596 (31.9%)	
Age (year)				<0.001
<29	4,418	3,328 (75.3%)	1,090 (24.7%)	
30–39	6,999	5,059 (72.3%)	1,940 (27.7%)	
40–49	7,881	5,523 (70.1%)	2,358 (29.9%)	
50–59	7,532	5,028 (66.8%)	2,504 (33.2%)	
≥60	6,164	3,582 (58.1%)	2,582 (41.9%)	
Education				<0.001
Middle school or lower	4,012	2,123 (52.9%)	1,889 (47.1%)	
High school	11,339	7,488 (66.0%)	3,851 (34.0%)	
College or higher	17,592	12,881 (73.2%)	4,711 (26.8%)	
Monthly income (10,000 won/month)				<0.001
<200	10,551	6,547 (62.1%)	4,004 (37.9%)	
200–299	10,525	7,306 (69.4%)	3,219 (30.6%)	
300–399	6,170	4,496 (72.9%)	1,674 (27.1%)	
≥400	4,348	3,253 (74.8%)	1,095 (25.2%)	
Employment type				<0.001
Regular worker	25,239	17,794 (70.5%)	7,445 (29.5%)	
Temporary worker	5,840	3,705 (63.4%)	2,135 (36.6%)	
Daily worker	1,915	1,021 (53.3%)	894 (46.7%)	
Weekly working hours (hr/week)				<0.001
<40 h	7,598	4,720 (62.1%)	2,878 (37.9%)	
40–52 h	22,369	15,948 (71.3%)	6,421 (28.7%)	
>52 h	2,872	1,792 (61.4%)	1,110 (38.6%)	
Work duration (year)				<0.001
<1 y	5,793	3,768 (65.0%)	2,025 (35.0%)	
1–5 y	12,291	8,470 (68.9%)	3,821 (31.1%)	
>5 y	14,569	10,071 (69.1%)	4,498 (30.9%)	
Shift Work				0.140
Yes	3,295	2,211 (67.1%)	1,084 (32.9%)	
No	29,591	20,229 (68.4%)	9,362 (31.6%)	
Working time				<0.001
Full-time	26,622	18,558 (69.7%)	18,558 (69.7%)	
Part-time	6,218	3,855 (62.0%)	3,855 (62.0%)	
Occupational groups				<0.001
White-collar worker	14,162	10,349 (73.1%)	3,813 (26.9%)	
Pink-collar worker	7,744	5,381 (69.5%)	2,363 (30.5%)	
Blue-collar worker	11,088	6,790 (61.2%)	4,298 (38.8%)	
Work during work outside of regular working hours and communication devices				<0.001
No work outside of regular working hours	30,107	20,629 (68.5%)	9,478 (31.5%)	
Work outside of regular working hours with use of work-related communication devices	2,389	1,604 (67.1%)	785 (32.9%)	
Work outside of regular working hours with no use of work-related communication devices	498	287 (57.6%)	211 (42.4%)	

hours as a reference, the odd ratio of the group working outside of regular working hours was 1.27 (95% CI: 1.17–1.38). In addition, compared to the group that did not work outside of regular working hours, the odds ratio of the group using work-related communication devices when working outside of regular working hours was 1.20 (95% CI: 1.09–1.32), and for those who did not use work-related communication devices, the odds ratio was 1.66 (95% CI: 1.37–2.00), indicating a higher relevance of depressive symptoms.

Furthermore, in order to show the effect of work-related communication devices use during work outside of regular working hours, an additional analysis was conducted comparing a group that used work-related communication devices for work and a group that did not use them. In the model adjusted for socio-demographic and work-related factors, when comparing the group that used communication devices for work during work outside of regular working hours, the odds ratio of the group that did not use communication devices for work during work outside of regular working hours work was 1.56 (95% CI: 1.28–1.92), indicating a higher relevance of depressive symptoms.

#### 4. Discussion

This study investigated the effect of using work-related communication devices during work outside of regular working

hours on depressive symptoms in wage workers. Workers who worked outside of regular working hours had a higher incidence of depressive symptoms than those who did not work outside of regular working hours. In addition, workers who did not use work-related communication devices during work outside of regular working hours had a higher incidence of depressive symptoms than workers who used work-related communication devices during work outside of regular working hours. This association was significant even after controlling for confounding factors. This suggests that the use of work-related communication devices for work during work outside of regular working hours is related to depressive symptoms in wage workers.

In this study, the rate of depressive symptoms among workers was high when working outside of regular working hours. This result is consistent with previous research showing that long working hours have a negative effect on workers' mental health [17–21]. However, previous studies focused on the relationship between total working hours and depressive symptoms, and this study is different in that it investigates the relationship between depressive symptoms and a wider range of hours worked, specifically the hours meant for rest and personal activities. Also, Working outside of regular working hours is when an employee works outside of the internally set work days and commute hours, and is when an employee works inside or outside the company

**Table 2**

The odds ratios (ORs) and 95% CIs of work outside of regular working hours using work-related communication devices and depressive symptoms

Work outside of regular working hours	Model 1	Model 2	Model 3
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Work outside of regular working hours			
No	1.00	1.00	1.00
Yes	1.15 (1.06–1.25)	1.24 (1.14–1.35)	1.27 (1.17–1.38)
Not working outside of regular working hours	1.00	1.00	1.00
Working with work-related communication devices use outside of regular working hours	1.07 (0.98–1.17)	1.17 (1.07–1.28)	1.20 (1.09–1.32)
Working without work-related communication devices use outside of regular working hours	1.614 (1.35–1.93)	1.63 (1.36–1.96)	1.66 (1.37–2.00)
Working with work-related communication devices use outside of regular working hours	1.00	1.00	1.00
Working without work-related communication devices use outside of regular working hours	1.50 (1.23–1.83)	1.50 (1.23–1.83)	1.56 (1.28–1.92)

CI, confidence interval; OR, odds ratio.

Model 1 was crude.

Model 2 was adjusted for sex, age, and education.

Model 3 was adjusted by sex, age, education, and work-related factors (monthly income, employment type, weekly working hour, work duration, working time, occupational group).

outside of official overtime. It refers to a situation in which you have to work at home or at the company due to the company's request, even though it is not official business hours, such as after work hours, holidays, and vacation periods. On the other hand, long-time work refers to working in excess of the average regular working hours per week (40 hours per week) excluding break time, in accordance with Article 50 of the Labor Standards Act of the Republic of Korea [37]. The similarity between working outside of regular working hours and long-time work is that total working hours increase. The difference between these two concepts is that work outside of regular working hours other than regular working hours works informally not only after work, but also during some official breaks (e.g., breaks, meal times, etc.), and the boundary between work and rest tends to be ambiguous. On the other hand, the difference is that long-time work at official overtime hours or that exceed the average regular working hours per week. Working outside of regular working hours is when you work at times other than internally set work days and commuting hours, and you work inside and outside the company in addition to official additional work or overtime.

This study mainly shows the effect of work-related communication devices use on depressive symptoms when working outside of regular working hours. With the recent development of communication technology, it is possible to process work outside the company, increasing work flexibility. It can be assumed that the use of communication devices during work outside of regular working hours will reduce depressive symptoms compared to when communication devices are not used. This is consistent with previous studies which showed that the use of communication devices at work has a positive effect on mental health by improving work flexibility, autonomy, and job satisfaction [31,38,39].

In contrast to the findings of this study, previous studies have shown that work-related communication devices affect workers negatively. For example, in a study of full-time employees in the United States, there was a study that the recent rapid development of communication technology could cause emotional exhaustion in workers and hinder organizational efficiency by using work-related communication during non-working hours [40]. It was in line with this study that the use of communication devices after regular working hours could potentially threaten the psychological well-being of workers. However, previous studies viewed the development of communication devices as an increase in communication after-hours and emotional exhaustion, but in this study, the difference was that increased work flexibility due to the use of communication devices would have a positive impact on workers' mental health. Also, a study showed that the rapid development of communication devices and the need to learn how to use them for

work caused "technostress" to workers, which decreased job satisfaction [41]. However, that study dealt with the negative effects of difficulties in learning new communication devices technologies as it was conducted before the use of communication devices for work became widespread [27]. Likely, the stress of learning new communication devices technologies in the present day is no longer substantial. This study is different as it investigates the effect of using communication devices during a time when the use of such devices for work is already widespread. Another contrasting previous finding is that the autonomy allowed by the use of work-related communication devices at work blurs the boundary between work and family and causes workers to overwork, which can create an imbalance between work and personal life [42].

The results of this study can be explained based on the model of conservation of resources theory. The model of conservation of resources is a theory that people try to conserve valuable and useful job resources and experience psychological stress when they do not have enough job resources or lose them [43]. Things of value to an individual include all job resources, such as object resources (e.g., physical possessions), condition resources (e.g., social roles, employment), personal characteristic resources (e.g., views of the self, gender), and energy resources (e.g., money, time, knowledge). Hobfoll said that loss of job resources is perceived disproportionately more prominently than resource acquisition [44]. This loss of job resources can cause psychological stress such as disappointment, helplessness, and depression to individuals. According to this theory, for workers who work outside of regular working hours, work-related communication devices at work are job resources, and the loss of these job resources can cause psychological stress when working outside of regular working hours. Therefore, this can be inferred as a mechanism for the association between the use of work-related communication devices during work outside of regular working hours and depressive symptoms.

In addition, the frequency of work-related communication device use during work outside of regular working hours varies by industry and occupational group. In a survey of wage workers in Republic of Korea in 2015, the percentage of workers who used work-related communication devices during work outside of regular working hours by industry was the highest at 89.0% in the case of Information and communication service industries [27]. It was followed by professional, scientific and technical services (81.9%), educational services (71.0%), manufacturing (69.6%), finance and insurance (65.7%), business facility management and business support services (64.8%), health and social work services (60.1%). By occupational group, managers showed the highest rate at 85.4%, and sales (79.6%) and office workers (71.8%) also showed a significantly higher rate of over 70%. It was followed by professionals and

related workers (65.2%), service workers (54.5%), technical assembly jobs (54.5%), agricultural jobs (54.5%), and simple labor jobs (45.7%) [27]. Based on these results, it can be assumed that the use of work communication devices will reduce depressive symptoms in industries that frequently use work communication devices during work outside of regular working hours, such as information and communication service, professional, scientific and technical services, educational service workers, managers, sales workers, and office workers. On the other hand, health and social work service industry that primarily provides face-to-face services has a low frequency of using communication devices when working outside of regular working hours. In addition, labor-intensive occupations such as technology assembly jobs, agricultural jobs, and simple labor jobs use communication devices relatively less frequently when working outside of regular working hours due to the nature of their work. Therefore, it can be inferred that workers who provide face-to-face services or do labor-intensive occupations have less effect on reducing depressive symptoms when working outside of regular working hours.

The strength of this study is that the Korea Occupational Safety and Health Corporation has studied all Korean wage workers with reliable data collected using survey methods (one-on-one interview survey by investigators) and sample design and extraction. Another advantage is that most of the previous studies focused on the relationship between total working hours and depression, but this study is, to the best of our knowledge, the first to analyze the connection between depression and the use of work-related communication devices during work outside of regular working hours, which is a rising trend among workers.

However, this study has some limitations. First, it is difficult to accurately define causality in a cross-sectional study using a self-reported questionnaire. In a causal relationship, there is a possibility that work-related communication devices use and depressive symptoms may change when working outside of regular working hours, so this will need to be confirmed through a cohort study. Second, since this study analyzed whether working outside of regular working hours was divided into categorical types, the quantitative analysis of actual specific hours was not performed properly. Therefore, additional research is needed to perform a quantitative analysis of these independent and dependent variables as continuous variables.

## 5. Conclusion

Regardless of whether work-related communication devices are used, working outside of regular working hours increases depressive symptoms. However, using communication devices while in work outside of regular working hours can reduce the rate of depressive symptoms relative to not using them.

## Funding

This work was supported by Inha University.

## Conflicts of interest

The authors declare no conflict of interest.

## References

- [1] World Health Organization. Depression and other common mental disorders: global health estimates. Geneva (Switzerland): World Health Organization; 2017. 10 p.
- [2] Lipton RB, Schwedt TJ, Friedman BW. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* 2016;388(10053):1545–602.
- [3] Lim GY, Tam WW, Lu Y, Ho CS, Zhang MW, Ho RC. Prevalence of depression in the community from 30 countries between 1994 and 2014. *Sci Rep* 2018;8(1):2861.
- [4] Wulsin L, Alterman T, Timothy Bushnell P, Li J, Shen R. Prevalence rates for depression by industry: a claims database analysis. *Soc Psychiatry Psychiatr Epidemiol* 2014;49(11):1805–21.
- [5] Kessler RC, Merikangas KR, Wang PS. The prevalence and correlates of workplace depression in the national comorbidity survey replication. *J Occup Environ Med/Am Coll Occup Environ Med* 2008;50(4):381.
- [6] Adler DA, McLaughlin TJ, Rogers WH, Chang H, Lapitsky L, Lerner D. Job performance deficits due to depression. *Am J Psychiatry* 2006;163(9):1569–76.
- [7] Wang PS, Beck AL, Berglund P, McKeen DK, Pronk NP, Simon GE, Kessler RC. Effects of major depression on moment-in-time work performance. *Am J Psychiatry* 2004;161(10):1885–91.
- [8] WHO World Mental Health Survey Consortium. Prevalence, severity, and unmet need for treatment of mental disorders in the World Health Organization World Mental Health Surveys. *JAMA* 2004;291(21):2581–90.
- [9] Greenberg PE, Fournier A-A, Sisitsky T, Pike CT, Kessler RC. The economic burden of adults with major depressive disorder in the United States (2005 and 2010). *J Clin Psychiatry* 2015;76(2):5356.
- [10] Kessler RC. The costs of depression. *Psychiatr Clin* 2012;35(1):1–14.
- [11] Faragher EB, Cass M, Cooper CL. The relationship between job satisfaction and health: a meta-analysis. *Occup Environ Med* 2005;62(2):105–12.
- [12] Stansfeld S, Candy B. Psychosocial work environment and mental health—a meta-analytic review. *Scand J Work Environ Health* 2006;443–62.
- [13] Torquati L, Mielke GI, Brown WJ, Burton NW, Kolbe-Alexander TL. Shift work and poor mental health: a meta-analysis of longitudinal studies. *Am J Public Health* 2019;109(11):e13–20.
- [14] Madsen IEH, Nyberg ST, Magnusson Hanson LL, Ferrie JE, Ahola K, Alfredsson L, Batty GD, Bjorner JB, Borritz M, Burr H, Chastang J-F, Graaf RD, Hamer DM, Jokela M, Knutsson A, Koskenvuo M, Koskinen A, Leineweber C, Niedhammer I, Nielsen ML, Nordin M, Oksanen T, Pejtersen JH, Pentti J, Plaisier I, Salo P, Singh-Manoux A, Suominen S, Ten Have M, Theorell T, Toppinen-Tanner S, Vahtera J, Väänänen A, Westerholm P, M J, Westerlund H, Fransson EI, Heikkilä K, Virtanen M, Rugulies R, Kivimäki IM. Job strain as a risk factor for clinical depression: systematic review and meta-analysis with additional individual participant data. *Psychol Med* 2017;47(8):1342–56.
- [15] Sparks K, Cooper C, Fried Y, Shirom A. The effects of hours of work on health: a meta-analytic review. *J Occup Organ Psychol* 1997;70(4):391–408.
- [16] Theorell T, Hammarström A, Aronsson G, Träskman Bendz L, Grape T, Hogstedt C, Martensdottir I, Skoog I, Hall C. A systematic review including meta-analysis of work environment and depressive symptoms. *BMC Public Health* 2015;15(1):1–14.
- [17] Bannai A, Tamakoshi A. The association between long working hours and health: a systematic review of epidemiological evidence. *Scand J Work Environ Health* 2014;5–18.
- [18] Milner A, Smith P, LaMontagne AD. Working hours and mental health in Australia: evidence from an Australian population-based cohort, 2001–2012. *Occup Environ Med* 2015;72(8):573–9.
- [19] Yoon JH, Jung PK, Roh J, Seok H, Won JU. Relationship between long working hours and suicidal thoughts: nationwide data from the 4th and 5th Korean National Health and Nutrition Examination Survey. *PLoS One* 2015;10(6):e0129142.
- [20] Kim W, Park EC, Lee TH, Kim TH. Effect of working hours and precarious employment on depressive symptoms in South Korean employees: a longitudinal study. *Occup Environ Med* 2016;73(12):816–22.
- [21] Kleppa E, Sanne B, Tell GS. Working overtime is associated with anxiety and depression: the Hordaland Health Study. *J Occup Environ Med* 2008;50(6):658–66.
- [22] Lee HE, Kawachi I. Association between unpredictable work schedules and depressive symptoms in Korea. *Saf and Health Work* 2021;12(3):351–8.
- [23] Arlinghaus A, Bohle P, Iskra-Golec I, Jansen N, Jay S, Rotenberg L. Working Time Society consensus statements: evidence-based effects of shift work and non-standard working hours on workers, family and community. *Ind Health* 2019;57(2):184–200.
- [24] Henly JR, Lambert SJ. Unpredictable work timing in retail jobs: implications for employee work–life conflict. *ILR Review* 2014;67(3):986–1016.
- [25] Winkler MR, Mason S, Laska MN, Christoph MJ, Neumark-Sztainer D. Does non-standard work mean non-standard health? Exploring links between non-standard work schedules, health behavior, and well-being. *SSM Popul Health* 2018;4:135–43.
- [26] Allen TD, Golden TD, Shockley KM. How effective is telecommuting? Assessing the status of our scientific findings. *Psychol Sci Public Interest* 2015;16(2):40–68.
- [27] Lee KH, Kim GS. The impact of smart devices usage on the work and life of workers. Seoul (Korea): Korea Labor Research Institute; 2015. p. 43–5.
- [28] Maitland A, Thomson P. Future work (Expanded and Updated): changing organizational culture for the new world of work. Springer; 2014.
- [29] Nansen B, Arnold M, Gibbs M, Davis H. Time, space and technology in the working-home: an unsettled nexus. *New Technol Work Employ* 2010;25(2):136–53.
- [30] O'Driscoll MP, Brough P, Timms C, Sawang S. Engagement with information and communication technology and psychological well-being. In: New developments in theoretical and conceptual approaches to job stress. Emerald Group Publishing Limited; 2010. p. 269–316.

- [31] Sardeshmukh SR, Sharma D, Golden TD. Impact of telework on exhaustion and job engagement: a job demands and job resources model. *New Technol Work Employ* 2012;27(3):193–207.
- [32] Boswell WR, Olson-Buchanan JB. The use of communication technologies after hours: the role of work attitudes and work-life conflict. *J Manage* 2007;33(4): 592–610.
- [33] Howard J. Nonstandard work arrangements and worker health and safety. *Am J Ind Med* 2017;60(1):1–10.
- [34] Parent-Thirion A, Biletta I, Cabrita J, Vargas Llave O, Vermeylen G, Wilczyńska A, Wilkens M. Eurofound. Sixth European working conditions survey—overview report; 2016.
- [35] Deming WE, Stephan FF. On a least squares adjustment of a sampled frequency table when the expected marginal totals are known. *Ann Math Stat* 1940;11(4):427–44.
- [36] Topp CW, Østergaard SD, Søndergaard S, Bech P. The WHO-5 Well-Being Index: a systematic review of the literature. *Psychother Psychosom* 2015;84(3):167–76.
- [37] Sect. 50 Labor Standard Act [Internet]; Feb 1, 2012. Available from: [https://elaw.klri.re.kr/eng\\_service/lawView.do?hseq=25437&lang=ENG](https://elaw.klri.re.kr/eng_service/lawView.do?hseq=25437&lang=ENG).
- [38] Anderson AJ, Kaplan SA, Vega RP. The impact of telework on emotional experience: when, and for whom, does telework improve daily affective well-being? *Eur J Work Organ Psychol* 2015;24(6):882–97.
- [39] Gephart JR, Robert P. Introduction to the brave new workplace: organizational behavior in the electronic age. *J Organ Behav: Int J Ind Occup Organ Psychol Behav* 2002;23(4):327–44.
- [40] Kim KH, Chon M-G. When work and life boundaries are blurred: the effect of after-hours work communication through communication technology on employee outcomes. *J Commun Manag* 2022;26(4):386–400.
- [41] Suh A, Lee J. Understanding teleworkers' technostress and its influence on job satisfaction. *Internet Res* 2017;27(1):140–59.
- [42] Tietze S, Musson G. Recasting the home-work relationship: a case of mutual adjustment? *Organ Stud* 2005;26(9):1331–52.
- [43] Hobfoll SE. Conservation of resources: a new attempt at conceptualizing stress. *Am Psychol* 1989;44(3):513.
- [44] Hobfoll SE. The influence of culture, community, and the nested-self in the stress process: advancing conservation of resources theory. *Appl Psychol* 2001;50(3): 337–421.