

# Association Between Working Hours and Depressive Symptoms Among Korean Employees

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**Objectives** Many studies have reported noticeable increases in the proportion of employees working either relatively short or relatively long hours. Such trends have been accompanied by an increasing concern that how much subjective mental well-being of employees would be influenced by their hours of work. The aim of this study was to investigate the association between work hours and clinically relevant depressive symptoms with demographic variables adjusted.

**Methods** Participants were employees of a total of 56 private companies and local government organizations in Korea, aged 19 to 65 years. A self-report questionnaire that included items on working hour, job stress, levels of depression, and socio-demographic factors was administered to 15360 Korean employees, with 14477 valid responses. Hierarchical linear regression analyses, adjusted for sociodemographic factors, job related demographic factors, job stress, were used additionally to estimate the association between working hours and depressive scores.

**Results** We found that working more than 40 hours per week correlated positively with the level of depressive symptoms after adjusting for demographic variables and the level of job stress. Furthermore, working 40 or fewer hours per week correlated negatively with the level of depressive symptoms. Being younger ( $\beta = -0.078$ ,  $\beta = -0.099$ ), being a female ( $\beta = 2.770$ ,  $\beta = 1.268$ ), and possessing a lower level of education ( $\beta = -0.315$ ,  $\beta = -1.125$ ) were significantly associated with higher level of depressive symptoms in all respondents.

**Conclusions** Both of working excessively long or short hours is significantly associated with the prevalence of depressive symptoms. Establishing proper office hours for employees is critical to improving the quality of working conditions and maintaining good mental health in the workplace.

**Keywords** Depression; Occupational health; Occupational stress; Workload; Mental health.

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## Introduction

In industrialized nations, the average number of working hours per week has generally decreased in recent decades, but variations

in the structure of the average workweek have increased.<sup>1,2)</sup> Many studies have reported an increase in the number of workers who work excessively long or short hours. Long working hours are characteristically prominent in East Asian countries, especially in Japan and Korea.<sup>1)</sup> According to country-specific working-hour data published by the Organization for Economic Cooperation and Development (OECD) in 2020, Koreans work an average of

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1908 hours per year, which is significantly higher than the OECD average of 1687 hours and is the fourth highest in the world.

Many studies have reported an increase in the risk of depression for people working long hours,<sup>1-11)</sup> but that research has primarily analyzed data from Western countries or used small samples<sup>8)9)</sup> from specific occupations, such as doctors.<sup>7)10)12)</sup> Furthermore, those studies merely confirmed the presence or absence of depression according to working hours and were unable to confirm the relationship between working hours and depression severity.

Recent studies have shown that working not only too many but also too few hours can affect workers' mental health. Few studies have examined the relationship between low employment and depression, and some of those have conceptualized situations in which the working environment does not match workers' preferred time, wage, and position as "work hour mismatch."<sup>1)2)13)14)</sup> Specifically, cases in which workers are unable to work as many hours as they want have been referred to as "underemployment." Studies found that underemployment caused unstable employment and low-wage problems due to non-regular and part-time work, which worsened physical and mental health due to decreased activity. However, those studies rarely analyzed the relationship between actual working hours and depression in employees in their samples with below-average working hours.

Problems in the working environment are a major source of chronic stress. For example, inadequate working hours cause negative emotional reactions such as anger and frustration and physiological changes such as increased blood pressure and muscle tension in the short term; in the long term, they increase workers' risks of developing mental and physical illnesses.<sup>15)16)</sup> Chronic stress can lead to absenteeism (absence from the workplace due to ill health) or presenteeism (presence at the workplace despite ill health, but with reduced productivity), both of which lower productivity in the corporate environment or society.

In this study, demographic variables, socio-statistic variables, and workplace stress were adjusted in steps for approximately 15000 Korean workers to evaluate the relationship between working hours and the severity of depressive symptoms as a continuous variable. This study is significant for its evaluation of the association between working hours and the severity of depressive symptoms across a working-hour spectrum ranging from 1 to 100 hours/week and its estimation of the number of working hours appropriate to prevent depression.

## Methods

### Participants

This research was conducted as a part of the Kangbuk Sam-

sung Workplace Mental Health study, a cross-sectional survey of Korean workers aged 19 to 65 years who attended a workplace mental health check-up program at Kangbuk Samsung Hospital, Seoul, Korea. Participants employed by 56 companies and local governmental organizations were invited to voluntarily participate in the mental health examination from June 2015 to October 2019 (n = 15360; valid answer, 14477, 92.4%).

### Measures

#### Dependent variable

The severity of depressive symptoms was assessed with the Korean version of the Center for Epidemiologic Studies Rating Scale for Depression (CES-D).<sup>17-19)</sup> The standard cutoff point of 16 or more was used to classify patients with depressive symptoms.<sup>20)</sup>

#### Independent variables

The socio-demographic factors collected as independent variables were age, sex, level of education, and marital status. Job-related demographic factors were also collected: position and duration of work at the current workplace. Job stress was assessed using the Short Form of the Korean Occupational Stress Scale (KOSS-SF).<sup>21)22)</sup>

We defined working hours as the number of hours participants worked per week on average each year, including overtime and night duty working hours. According to the Ministry of Employment and Labor's Yearbook of Employment and Labor Statistics 2019, average working hours across all industries were 171.2 hrs per month, or 39.39 hrs per week. Mindful of the lack of consensus across industries regarding appropriate working hours, we referred to legislations on the standard working hours of 40 to 44 hours per week in many other OECD countries such as the US,<sup>23)</sup> Germany,<sup>24)</sup> and Japan.<sup>25)</sup> We thus split employees into two groups: those working more than 40 hours per week and those working 40 or fewer hours per week.

#### Statistical analysis

For the univariate analyses, we used Mann-Whitney-U tests and chi-square tests. Pearson's correlation and multicollinearity diagnostics confirmed that multicollinearity was not an issue in our data. For the multivariate analyses, we performed hierarchical linear regression analyses using the CES-D scores as the dependent variable. We divided participants into two groups based on the reference point of 40 hours, the legal number of working hours in Korea. Model 1 tested the associations of socio-demographic factors with the severity of depressive symptoms. Job-related demographic factors, Job stress (measured by KOSS-SF), and working hours were added in Model 2, 3, and 4, respectively.

All these analyses were repeated in both groups with working hours of more than 40 hours and 40 or fewer hours per week. A re-analysis was conducted based on the median value in the study data, 44 hours. Statistical significance was set a priori at  $\alpha = 0.05$  (two-sided) to limit Type-I errors. Additionally, multiple logistic regression was used to analyze the association between working hour and the severity of depressive symptoms according to those factors. All analyses were conducted using the PASW statistics for windows, version 18 (SPSS Inc., Chicago, IL, USA).

**Ethics statement**

The protocol for this study was reviewed and approved by the Institutional Review Board (IRB) of Kangbuk Samsung Hospital (IRB No. KBSMC 2019-01-042). The IRB waived the informed

consent requirement because de-identified data routinely collected from workplace mental health screenings were used.

**Results**

**Participant characteristics**

Table 1 summarizes the descriptive information for socio-demographic factors, job-related demographic factors, job stress, the severity of depressive symptoms (CES-D) and working hours. We created depression and non-depression groups using a CES-D score threshold of 16 points and found that working hours were associated with depression, age, sex, level of education, and workplace position.

**Table 1.** Socio-demographic and psychological characteristics of the study population

Variables	Min	Max	Total (n = 14477)	Univariate analyses*			
				No depression group (n = 11411)	Depression group (n = 3066)	z/ $\chi^2$	p
Age, years	16	72	39.2 ± 9.3	39.8 ± 9.3	36.91 ± 8.9	-15.3	< 0.001**
Sex						229.4	< 0.001**
Male			8490 (55.3)	7059 (83.1)	1431 (16.9)		
Female			5987 (44.7)	4352 (72.7)	1635 (27.3)		
Education†						30.6	< 0.001**
High school graduate			1727 (12.6)	1369 (12.7)	358 (12.4)		
College			2596 (19.0)	1971 (18.3)	625 (21.7)		
University			8073 (59.1)	6387 (59.2)	1686 (58.6)		
Master's degree			1264 (9.3)	1056 (9.8)	208 (7.3)		
Marital status‡						0.5	0.790
Married			8800 (60.8)	6932 (60.7)	1868 (60.9)		
Unmarried			4697 (32.4)	3698 (32.4)	999 (32.6)		
Other			980 (6.8)	781 (6.8)	199 (6.5)		
Position§						111.5	< 0.001**
Executive			432 (2.9)	379 (3.3)	53 (1.7)		
Senior			4050 (28.0)	3376 (29.6)	674 (22.0)		
Junior			9195 (63.5)	7083 (62.1)	2112 (69.0)		
Other			795 (5.6)	571 (5.0)	224 (7.3)		
Job duration, years	0	42	11.0 ± 9.5	11.5 ± 9.3	11.6 ± 37.4	-0.3	0.730
KOSS-SF	0	104	61.4 ± 9.6	61.4 ± 9.6	61.4 ± 9.6	-0.4	0.660
CES-D	0	60	10.0 ± 9.5	5.94 ± 4.25	25.04 ± 8.55		
Hours of work per week	1	100	44.1 ± 17.3				
≤ 40 hours	1	40	23.8 ± 15.3	24.4 ± 15.4	21.5 ± 15.1	-4.0	< 0.001**
> 40 hours	41	100	52.8 ± 8.5	52.6 ± 8.4	53.5 ± 9.0	-4.4	< 0.001**
≤ 44 hours	1	44	25.87 ± 15.6	27.33 ± 15.62	24.62 ± 15.84	-3.552	< 0.001**
> 44 hours	45	100	53.41 ± 8.37	53.22 ± 8.26	54.16 ± 8.77	-4.621	< 0.001**

Data are presented as mean ± standard deviation or number (%). No-depression group: CES-D < 16; Depression group: CES-D ≥ 16. \*Univariate analyses (Mann-Whitney-U tests for continuous variables and chi-square tests for categorical variables) were conducted with depression as the dependent variable; †Educational level (high) includes master's and doctorate degrees (Valid answer = 13660, missing rate = 6.64%); ‡Marital status (single) includes never married; §Job grade (high) includes executive team members (Valid answer = 14472, missing rate = 0.03%); \*\*p < 0.001. CES-D, Center for Epidemiologic Studies Rating Scale for Depression; KOSS-SF, Short Form of the Korean Occupational Stress Scale

**Hierarchical linear regression analyses with the CES-D score as the dependent variable and working hours as the independent variable in the group with working hours of more than 40 hours per week**

The results of the hierarchical linear regression analyses of the association between the level of depressive symptoms and socio-demographic factors, job-related demographic factors, job stress, and working hours are summarized in Table 2. A strong positive association was found between working more than 40 hours ( $p < 0.001$ ) and the CES-D score in Model 4 (Fig. 1). This final model explained 3.5% of the variance in the level of depressive symptoms. Furthermore, in Model 4, the relative influence of the significant variables was defined as the magnitude of the absolute value of the standardized coefficient  $\beta$ . A comparison showed that the variables influenced the CES-D score in the following order: age ( $\beta = -0.078$ ), being a male ( $\beta = 2.770$ ), lower education ( $\beta = -0.315$ ), job duration ( $\beta = 0.008$ ), and working more hours ( $\beta = 0.082$ ).

**Hierarchical linear regression analyses with the CES-D score as the dependent variable and working hours as the independent variable in the group with working hours of 44 hours or fewer per week**

The results of the hierarchical linear regression analysis of the association between the level of depressive symptoms and socio-demographic factors, job-related demographic factors, job stress, and working hours are summarized in Table 3. A strong negative association existed between working 40 or fewer hours ( $p < 0.001$ ) and the CES-D score in Model 4 (Fig. 1). This final model explained 3.7% of the variance in the level of depressive symptoms. A comparison showed that variables influenced the CES-D score in the following order: age ( $\beta = -0.099$ ), being a male ( $\beta = 1.268$ ), lower education ( $\beta = -1.125$ ), being unmarried ( $\beta = 0.704$ ), and working fewer hours ( $\beta = -0.063$ ).

**Hierarchical linear regression analyses with groups divided by average working hours and multiple logistic regression analysis of the association between work hour and the severity of depressive symptoms**

We also performed the same hierarchical linear regression analyses with the reference point of 44 hours, which was the average number of working hours per week in our data. There was no significant change to the previous results (Tables 4 and 5). Table 6 indicates the results of the multiple logistic regression analysis of factors associated with depressive symptoms. It was found that the lowest risk of depression was associated with the working hour group of 41–48 hours a week, which was similar to the reference point of 40 or 44 hours a week as in our study. The risk

**Table 2.** Hierarchical linear regression analyses with the CES-D score as the dependent variable and working hours as the independent variable in the group with working hours of more than 40 hours per week

	Model 1			Model 2			Model 3			Model 4		
	B	Beta	p	B	Beta	p	B	Beta	p	B	Beta	p
<b>Independent variables</b>												
<b>Socio-demographic factors</b>												
Age	-0.079	-0.077	-6.157	-0.081	-0.078	-5.818	-0.081	-0.078	-5.818	-0.078	-0.075	-5.628
Sex, male	2.551	0.130	10.693	2.553	0.130	10.654	2.553	0.130	10.652	2.770	0.141	11.478
Education, lower	-0.311	-0.027	-2.288	-0.319	-0.027	-2.221	-0.319	-0.027	-2.217	-0.315	-0.027	-2.200
Marital status, married	0.303	0.016	1.426	0.303	0.016	1.428	0.303	0.016	1.426	0.306	0.017	1.443
<b>Job-related demographic factors</b>												
Position, higher				-0.053	-0.003	-0.251	-0.052	-0.003	-0.247	-0.052	-0.006	-0.472
Job duration				0.008	0.028	2.414	0.008	0.028	2.430	0.008	0.028	2.470
Job stress												
KOSS-SF							0.003	0.003	0.273			
Working hours per week										-0.003	0.003	0.264
Statistics of the model	F = 55.815, $p \leq 0.001^{**}$ , $R^2 = 0.030$			F = 38.211, $p \leq 0.001^{**}$ , $R^2 = 0.030$			F = 32.759, $p \leq 0.001^{**}$ , $R^2 = 0.030$			F = 34.123, $p \leq 0.001^{**}$ , $R^2 = 0.035$		
	F change = 2.943			F change = 2.943			F change = 0.075			F change = 42.402		
	$R^2$ change $\leq 0.001$			$R^2$ change $\leq 0.001$			$R^2$ change $\leq 0.001$			$R^2$ change = 0.005		

Analysis was conducted in four phases with Model 1 testing the associations between the socio-demographic factors and the severity of depression, and Model 2 additionally incorporating job-related demographic factors, adjusted from Model 1. Model 3 further added job stress (KOSS-SF) to analyze its association beyond the effects of socio-demographic and job-related demographic factors. Finally, Model 4 included working for more than 40 hours as the last independent variable, to examine the association beyond the combined effect of the remainder. All analyses were repeated with participants working 40 hours or fewer as independent variables. \* $p < 0.05$ ; \*\* $p < 0.001$ . CES-D, Center for Epidemiologic Studies Rating Scale for Depression; KOSS-SF, Short Form of the Korean Occupational Stress Scale

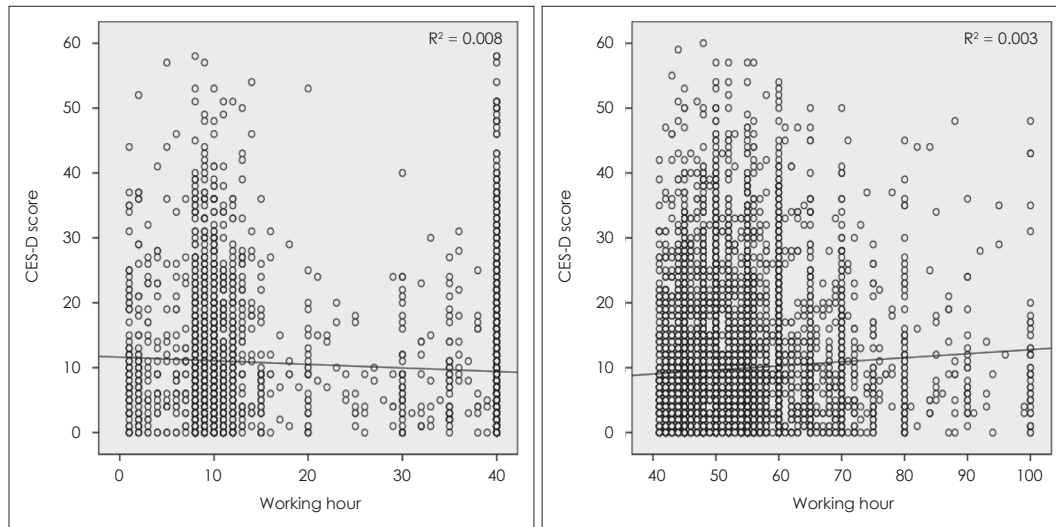


Fig. 1. Relationships between depression score and hours worked per week.

of depression was also significantly higher in participants with younger age, female, and low education.

## Discussion

In this study, we aimed to identify the relationship between the number of working hours for Korean employees, other factors, and the level of depressive symptoms. We discovered the U-shaped trend in the association between working hour and the level of depressive symptoms, as the severity of depressive symptoms neared the extremes both below and above the reference point of 40 hours of work per week.

Industrialization has caused many labor problems,<sup>26)</sup> and the Labor Standards Act was enacted in Korea to guarantee labor rights. The previous studies have focused and examined on the negative effects of exceeding a certain number of working hours rather than the effects of insufficient work time. Many previous studies have suggested that physical and mental health worsens and the severity of depressive symptoms increase as working hours increase.<sup>15)27)</sup> In the 5-Year Follow-Up of the Whitehall II Study published in 2011,<sup>14)</sup> the incidence of depression was 2.43 times higher in workers who worked 11 or more hours per day compared with workers who worked for an average of 7 to 8 hours per day. A previous study of the general population in the UK showed that female who worked for an average of 35 to 40 hours per week had fewer depression symptoms than female who worked for 55 or more hours per week.<sup>3)</sup> Several papers published in Korea, Japan, Canada, and Australia also identified a relationship between working hours and depression and found that depression increased as working hours increased in particular occupation.<sup>1)5)7)11)</sup>

Meanwhile, since the early 2010s, studies have reported that an increase in working hours might not increase the level of depressive symptoms.<sup>1)2)9)14)15)</sup> Instead, researchers have proposed that work-hour mismatch occurs when a person's actual number of working hours differs from what they prefer and that quality of life is only reduced when the actual number of working hours exceeds the preferred number of working hours.<sup>1)2)13)14)</sup> Those studies also suggest that working long hours can lower life satisfaction and increase the risk of depression by increasing the possibility of overemployment.<sup>9)</sup> In addition, overemployment accompanied by an increase in employment instability through irregular working patterns such as night work and weekend work could explain the associated increase in the level of depressive symptoms.<sup>5)28)</sup> Those possibilities are in line with our findings in this study.

On the other hand, few previous studies have examined the relationship between reductions in working hours and depression as a primary outcome. Previous studies examined only the abstract concept of work-hour mismatch by comparing the preferred number of working hours with the actual number of working hours,<sup>1)12)</sup> rather than examining the relationship between the absolute number of working hours and depression. In fact, some previous studies have argued that the two have no relationship. The Americans' Changing Lives (ACL) study published in 2003 analyzed the relationship between underemployment and health by subcategorizing underemployment by hours, income, skills, and status.<sup>14)</sup> That study explained that underemployment defined using low wages and job titles reduced workers' activity, resulting in a lack of confidence, chronic diseases, and depression, which is in line with the findings of other studies that found that low wages are associated with decreased self-esteem and de-

**Table 3.** Hierarchical linear regression analyses with the CES-D score as the dependent variable and working hours as the independent variable in the group with working hours of 44 hours or fewer per week

Independent variables	Model 1			Model 2			Model 3			Model 4						
	B	Beta	T	p	B	Beta	T	p	B	Beta	T	p				
Socio-demographic factors																
Age	-0.113	-0.108	-5.700	< 0.001**	-0.104	-0.100	-5.082	< 0.001**	-0.104	-0.100	-5.067	< 0.001**	-0.099	-0.095	-4.850	< 0.001**
Sex, male	1.366	0.069	3.627	< 0.001**	1.234	0.062	3.199	< 0.001**	1.236	0.062	3.205	< 0.001**	1.268	0.064	3.302	< 0.001**
Education, lower	-1.071	-0.092	-5.288	< 0.001**	-1.021	-0.088	-4.963	< 0.001**	-1.016	-0.087	-4.939	< 0.001**	-1.125	-0.097	-5.471	< 0.001**
Marital status, married	0.705	0.037	2.136	0.033*	0.707	0.037	2.144	0.032*	0.709	0.037	2.148	0.032*	0.704	0.037	2.144	0.032*
Job-related demographic factors																
Position, higher					0.513	0.030	1.566	0.117	0.525	0.031	1.599	0.110	0.614	0.036	1.878	0.060
Job duration					-0.002	-0.009	-0.505	0.614	-0.001	-0.006	-0.367	0.714	-0.003	-0.007	-0.375	0.708
Job stress									0.014	0.014	0.788	0.431	0.014	0.014	0.800	0.424
KOSS-SF																
Working hours per week																
Statistics of the model																
					F = 26.616, p ≤ 0.001**		R <sup>2</sup> = 0.032		F = 18.199, p ≤ 0.001**		R <sup>2</sup> = 0.033		F = 15.686, p ≤ 0.001**		R <sup>2</sup> = 0.033	
					F change = 1.456		R <sup>2</sup> change ≤ 0.001		F change = 4.147		R <sup>2</sup> change ≤ 0.001		F change = 32.500		R <sup>2</sup> change = 0.009	

Analysis was conducted in four phases with Model 1 testing the associations between the socio-demographic factors and the severity of depression, and Model 2 additionally incorporating job-related demographic factors, adjusted from Model 1. Model 3 further added job stress (KOSS-SF) to analyze its association beyond the effects of socio-demographic and job-related demographic factors. Finally, Model 4 included working for more than 40 hours as the last independent variable, to examine the association beyond the combined effect of the remainder. All analyses were repeated with participants working 40 hours or fewer as independent variables. \*p < 0.05; \*\*p < 0.001. CES-D, Center for Epidemiologic Studies Rating Scale for Depression; KOSS-SF, Short Form of the Korean Occupational Stress Scale

**Table 4.** Hierarchical linear regression analyses with the CES-D score as the dependent variable and working hours as the independent variable in the group with working hours of more than 44 hours per week

Independent variables	Model 1			Model 2			Model 3			Model 4						
	B	Beta	T	p	B	Beta	T	p	B	Beta	T	p				
Socio-demographic factors																
Age	-0.075	-0.073	-5.804	< 0.001**	-0.077	-0.075	-5.540	< 0.001**	-0.077	-0.074	-5.509	< 0.001**	-0.074	-0.072	-5.318	< 0.001**
Sex, male	2.696	0.137	11.153	< 0.001**	2.704	0.137	11.139	< 0.001**	2.724	0.138	11.213	< 0.001**	2.891	0.146	11.855	< 0.001**
Education, Lower	-0.340	-0.029	-2.491	< 0.001**	-0.357	-0.031	-2.470	< 0.001**	-0.361	-0.031	-2.493	< 0.001**	-0.348	-0.030	-2.409	< 0.001**
Marital status, married	-0.336	0.181	-1.854	0.117	-0.328	-0.021	-1.805	0.132	-0.315	-0.020	-1.733	0.124	-0.287	-0.018	-1.584	0.102
Job-related demographic factors																
Position, higher					0.001	0.004	0.377	0.488	0.001	0.002	0.172	0.338	0.001	0.002	0.178	0.355
Job duration					-0.077	-0.005	-0.366	0.377	-0.079	-0.005	-0.375	0.405	-0.127	-0.008	-0.601	0.357
Job stress									-0.021	-0.022	-1.854	0.055	-0.020	-0.021	-1.790	0.067
KOSS-SF																
Working hours per week																
Statistics of the model																
					F = 57.155, p ≤ 0.001**		R <sup>2</sup> = 0.030		F = 38.142, p ≤ 0.001**		R <sup>2</sup> = 0.030		F = 33.195, p ≤ 0.001**		R <sup>2</sup> = 0.030	
					F change = 0.144		R <sup>2</sup> change ≤ 0.001		F change = 3.438		R <sup>2</sup> change ≤ 0.001		F change = 37.335		R <sup>2</sup> change = 0.005	

Analysis was conducted in four phases with Model 1 testing the associations between the socio-demographic factors and the severity of depression, and Model 2 additionally incorporating job-related demographic factors, adjusted from Model 1. Model 3 further added job stress (KOSS-SF) to analyze its association beyond the effects of socio-demographic and job-related demographic factors. Finally, Model 4 included working for more than 44 hours as the last independent variable, to examine the association beyond the combined effect of the remainder. All analyses were repeated with participants working 44 hours or fewer as independent variables. \*p < 0.05; \*\*p < 0.001. CES-D, Center for Epidemiologic Studies Rating Scale for Depression; KOSS-SF, Short Form of the Korean Occupational Stress Scale

**Table 5.** Hierarchical linear regression analyses with the CES-D score as the dependent variable and working hours as the independent variable in the group with working hours of 44 or fewer hours per week

Independent variables	Model 1			Model 2			Model 3			Model 4		
	B	Beta	p	B	Beta	p	B	Beta	p	B	Beta	p
<b>Socio-demographic factors</b>												
Age	-0.111	-0.106	< 0.001**	-0.106	-0.102	< 0.001**	-0.107	-0.103	< 0.001**	-0.105	-0.101	< 0.001**
Sex, male	1.374	0.070	< 0.001**	1.313	0.067	< 0.001**	1.313	0.067	< 0.001**	1.320	0.067	< 0.001**
Education, lower	-1.039	-0.090	0.013*	-1.007	-0.087	0.014*	-1.002	-0.086	0.013*	-1.074	-0.093	0.016*
Marital status, married	-0.372	-0.024	0.064	-0.358	-0.023	0.071	-0.365	-0.024	0.083	-0.387	-0.025	0.113
<b>Job-related demographic factors</b>												
Position, higher		0.002	0.011	0.002	0.011	0.694	0.003	0.015	0.957	0.003	0.014	0.925
Job duration		0.262	0.015	0.883	0.714		0.247	0.014	0.833	0.272	0.016	0.920
Job stress							0.031	0.030	1.916	0.029	0.028	1.834
KOSS-SF										-0.053	-0.086	< 0.001**
Working hours per week												
Statistics of the model			F = 31.695, p ≤ 0.001**, R <sup>2</sup> = 0.029			F = 21.337, p ≤ 0.001**, R <sup>2</sup> = 0.029			F = 18.825, p ≤ 0.001**, R <sup>2</sup> = 0.030			F = 20.512, p ≤ 0.001**, R <sup>2</sup> = 0.037
			F change = 0.633			F change = 3.672			F change = 31.335			F change = 0.007
			R <sup>2</sup> change = 0.030			R <sup>2</sup> change = 0.001			R <sup>2</sup> change = 0.007			R <sup>2</sup> change = 0.007

Analysis was conducted in four phases with Model 1 testing the associations between the socio-demographic factors and the severity of depression, and Model 2 additionally incorporating job-related demographic factors; adjusted from Model 1. Model 3 further added job stress (KOSS-SF) to analyze its association beyond the effects of socio-demographic and job-related demographic factors. Finally, Model 4 included working for more than 44 hours as the last independent variable, to examine the association beyond the combined effect of the remainder. All analyses were repeated with participants working 44 hours or fewer as independent variables. \*p < 0.05; \*\*p < 0.001. CES-D, Center for Epidemiologic Studies Rating Scale for Depression; KOSS-SF, Short Form of the Korean Occupational Stress Scale

pression. A study done by Korea Occupational safety and Health Research institute revealed the South Korea's current state of underemployment that employed, elementary workers were the most vulnerable groups who agonize over underemployment. According to the industry, male workers in business facilities management and female workers in self-consumption production activities had the highest underemployment rate of 38.4% and 19.0%, respectively.<sup>15)</sup> However, as mentioned earlier, underemployment can be used to compare workers' preferred and actual number of working hours; thus, workaholic employees whose work hours exceed the legal maximum might still consider themselves underemployed.<sup>13)</sup> Therefore, it is unreasonable to regard those data as representative of the relationship between reductions in working hours and the level of depressive symptoms.

In this study, we examined the relationship between subjects' actual number of working hours and confirmed that the level of depressive symptoms increased as working hours decreased. According to the Korean National Health and Nutrition Examination Survey in 2013<sup>29)</sup> and the 11th Korean Labor Panel study in 2011,<sup>30)</sup> the proportion of non-regular workers and regular workers working part-time was 38.2% and 1.1%, respectively; compared with full-time workers, contract-workers were more likely to work less than 40 hours per week, be high school graduates, and receive a monthly wage of less than 1 million won. Similarly, a study on how working hours and employment insecurity affected depressive symptoms found that temporary (contract) workers had more symptoms of depression regardless of the number of working hours,<sup>5)31)</sup> indicating that temporary work is more likely to be paid less and have fewer opportunities for promotion and a poor working environment, resulting in a higher incidence of depressive symptoms. Meanwhile, the ACL study showed that decreases in actual working hours improved employees' satisfaction with their jobs. Those researchers explained their finding by operationally defining "hours underemployment" as working fewer than the desired number of hours in a job with which one is generally satisfied.

In this study, the level of depressive symptoms was higher in younger, less educated female in both groups (those working more and less than 40 hours a week). This is consistent with the general epidemiology of depression. The increase in the level of depressive symptoms in younger people could be due to the fact that young people are likely to suffer from adaptation disorders when they start working for the first time; the middle-aged population might not have been reflected in our data because those with severe depression would already have been transferred or resigned due to difficulties in maintaining employment.<sup>32)</sup> Next, those with lower levels of education are more likely to start their vocational activities with lower wages in lower positions than

**Table 6.** Multiple logistic regression analysis of factors associated with depressive symptoms in study participants

Variables	B	SE	Wals	df	Sig.	Exp (B)	95% CI for Exp (B)	
							Lower	Upper
Age	-0.029	0.003	80.807	1	< 0.001**	0.972	0.966	0.978
Sex, female	0.469	0.052	81.068	1	< 0.001**	1.598	1.443	1.770
Education					0.002*			
High school (ref)			14.959	3		1		
College	0.007	0.083	0.006	1	0.937	1.007	0.855	1.185
University	-0.188	0.074	6.391	1	0.011*	0.829	0.717	0.959
Master's degree	-0.254	0.115	4.896	1	0.027*	0.776	0.620	0.971
Marital status					0.275			
Married (ref)			2.585	2		1		
Unmarried	-0.013	0.103	0.016	1	0.899	0.987	0.807	1.207
Other	0.068	0.099	0.475	1	0.491	1.070	0.882	1.298
Position					0.033*			
Executive (ref)			8.765	3		1		
Senior	0.161	0.191	0.711	1	0.399	1.175	0.808	1.710
Junior	0.069	0.192	0.130	1	0.718	1.072	0.736	1.560
Other	0.344	0.212	2.628	1	0.105	1.411	0.931	2.140
Job duration	< 0.001	0.001	0.301	1	0.583	1.001	0.999	1.001
KOSS-SF	0.000	0.002	0.034	1	0.854	1.000	0.995	1.004
Hours of work per week					< 0.001**			
≤ 40 (ref)			35.793	3		1		
41–48	-0.136	0.067	4.144	1	0.042*	0.873	0.766	0.995
49–54	-0.030	0.069	0.192	1	0.662	0.970	0.848	1.111
≥ 55	0.254	0.064	15.861	1	< 0.001**	1.290	1.138	1.462
Constant	-0.467	0.311	2.254	1	0.133	0.627		

Multiple logistic regression was used to analyze the association between working hours and depression according to age, sex, education, marital status, position, job duration, and KOSS-SF. Employees were divided into four groups according to working hours (quartile 1: ≤ 40; quartile 2: 41–48; quartile 3: 49–54; quartile 4: ≥ 55). The results are reported as odds ratios and 95% confidence intervals (CI). \*p < 0.05; \*\*p < 0.001. KOSS-SF, Short Form of the Korean Occupational Stress Scale

highly educated people, and they are more likely to work non-salaried jobs, resulting in work instability, which can increase the level of depressive symptoms.<sup>11)29)</sup> Lastly, female are nearly twice as vulnerable to depression as male.<sup>33)</sup> They are more likely to be stressed by family affairs and interpersonal problems and likely to be employed for low wages in a male-dominated society.<sup>3)34)35)</sup> The combination of those factors can increase the level of depressive symptoms.

In summary, the working hours of office workers have a U-shaped relationship with their level of depressive symptoms after correcting for the influence of other external factors, including job stress. Therefore, too many and too few working hours negatively affect the mental health of individuals, reducing work efficiency and decreasing productivity at the organizational and social levels through increased use of sick leave or resignations. Therefore, it is important to ensure that employees are assigned an appropriate number of working hours.

The advantages and significance of this study are as follows. First, we examined the relationship between working hours and

the level of depressive symptoms in a relatively large dataset of 14477 Korean office workers. Second, many previous studies faced difficulties in confirming the correlation between the two variables on a continuous line because they used categorical variables in which working hours were grouped, and the level of depressive symptoms was classified simply by the presence or absence of clinically relevant depression. In this study, both variables were analyzed as continuous variables. Third, previous studies failed to examine the relationship between the level of depressive symptoms and the number of working hours below a reference point, so we investigated the correlation between the level of depressive symptoms and working more or less than 40 hours per week.

Despite the significance of this research, some limitations should be considered when interpreting our results. First, As the Previous studies in South Korea with cross-sectional design precluded researchers from analyzing many different variables simultaneously and confirming casual relationships, this study also has the same problems in those matters. It is necessary to conduct a cohort study or case-control study in sequence to clarify the casual



relationship. Second, information such as income level, physical illness, and a previous psychiatric medical history, which have been reported as risk factors for depression in other studies, was not collected. Particularly for people working 40 or fewer hours, there are limitations in interpreting our results because we have no data about the type of employment (salaried, non-salaried, part-time, or fixed-term employment, etc.) even though various types of employment could be present. An additional limitation is that data continuity cannot be secured for subjects working fewer than 40 hours because hardly any of our subjects worked from 20 to 40 hours per week (Fig. 1). Third, because our data are from a self-report questionnaire, self-report bias is inevitable, which could produce misleading descriptive statistics and casual inferences. Fourth, it is difficult to generalize our results to all industries in Korea because we examined only white-collar workers, rather than the general public. Fifth, we did not find any special differences when we analyzed our data by sex, although previous studies found differences in major stressors and risk factors by sex. It is thus necessary to obtain additional data and re-analyze the results by sex.

In conclusion, among the factors that aggravate job stress, working hours adversely affect the mental health of workers in both over- and underemployment situations. Higher level of depressive symptoms among employees causes work problems such as absenteeism and presenteeism, which can deteriorate the health of companies. To achieve maximum production efficiency while protecting workers' mental health, it is necessary to establish appropriate working hours for each employee, as well as appropriate systems and policies to this end.

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**Conflicts of interest**

The authors have no financial conflicts of interest.

**Author Contributions**

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