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Original Article

Depressive symptoms and risk of absence among workers in a manufacturing company: a 12-month follow-up study

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Abstract: Depression is a leading cause of reduced work ability and absence due to sickness. The objective of this study was to investigate how depressive symptoms are prospectively associated with subsequent absence, whether caused by illness or accidents, among manufacturing workers. This prospective study was conducted on 2,349 male and female employees that underwent a regular health examination at a university hospital. Depressive symptoms were measured at baseline using the Center for Epidemiologic Studies Depression (CES-D) Scale. Data on self-reported absence due to illness and accidents were obtained during a follow up of 1 yr. The incidences of sickness absence were 6.0% for men and 17.3% for women. Men and women with depressive symptoms (CES-D ≥16) were found to have higher odds of sickness absence during follow up (men: OR=4.06; 95% CI: 2.32–7.11; women: OR=1.75; 95% CI: 1.02–2.98), after adjustment for demographic and occupational factors. When depressive symptoms were divided into quartiles, significantly higher ORs of sickness absence were observed only among employees with the highest quartile of depressive symptoms. The study shows that depressive symptoms are a risk factor for future absence due to illness or accidents among manufacturing workers.

Key words: Absence, Accidents, Depression, Illness, Manufacturing workers, Korea

Introduction

Mental health disorders are considered main contributors to increasing sickness absence rates among employees[1)], and account for one-third of all new disability benefits among the Organization for Economic Cooperation and Development (OECD) member nations[2)]. In particular, depression is one of the costliest of health conditions in terms of disability, treatment, and indirect costs[3)]. In addition, as compared with other mental disorders, it has a greater adverse effect on work outcomes, including absenteeism, due to its high prevalence and recurrent-chronic nature[4)]. In a previous study, the prevalence of depressive symptoms was 11% (7.8% for men and 14% for women) in Koreans aged ≥19 yr in 2009[5)]. Depression imposes a substantial economic burden on Korean society, and in 2005 this was estimated to be $4,049 million[6)].

Many previous studies have reported prospective associations between depressive symptoms and sickness absence[7–12)]. A Dutch study conducted on a working population of 3,339 showed a significant association

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between depressive complaints, as determined using a well-validated depression scale (The Hospital Anxiety and Depression scale, HADS), and sickness absence duration in men (β=0.07; 95% CI: 0.05–0.09) and women (β=0.07; 95% CI: 0.04–0.11)[9]. In a Norwegian study of a general working population of 13,436, common mental disorders (as measured by HADS) were found to be related to the risk of sickness absence[10]. Thorsen *et al.*[11] reported that the presence of depression, as measured using the Major Depression Inventory (MDI) and the Mental Health Inventory (MHI-5), were associated with a higher odds of long-term sickness absence among Danish workers. However, some studies demonstrated a prospective association between depressive symptoms and sickness absence only in those with severe symptoms[8, 12, 13]. Furthermore, findings regarding the existence of a prospective association in both genders or in men only are inconsistent[7, 8].

In Korea, mean annual per person costs for absenteeism associated with depression are lower than in Japan, the United States, and Canada[14]. The incidence of absence among full-time employees in Korea was 9.2% for men and 10% for women in 2011[15], and the rate of absence due to depressive symptoms was 2% for men and 2.7% for women in 2014[16]. These results indicate that depression is poorly recognized and not disclosed to employers in the Korean workplace. One study reported that 8% of Korean workers do not tell their employers about their depression due to fear of losing their jobs[14].

The Center for Epidemiological Studies-Depression (CES-D) scale is one of the most frequently used measures of depressive experience[17]. However, few studies have examined the relationship between CES-D scores and absenteeism in a working population. Nakata *et al.*[18] reported a cross-sectional association between CES-D score and long-term sickness absence among shift workers. Another study investigated the relationship between sickness absence and CES-D score in a working population, but used depression as an outcome variable[19]. Somewhat surprisingly, no report has yet describe the relationship between depressive symptoms and absence in Korea manufacturing workers, although several studies have addressed relations between working conditions and psychosocial factors (job demands, job control, and social support) and workplace absenteeism or depressive symptoms[20–22]. However, reported rates of depressive symptoms widely differed[21, 22]. Furthermore, absence due to accidents is relatively less utilized as an index despite the growing attention being given to this issue, especially in industrialized countries, because the working population is rapidly aging and loss of work hours incurred by treatment and recovery directly increase overall accident-related costs[20]. The objective of the present study was to examine how depressive symptoms are prospectively associated with absence from work due to illness and accidents in Korean manufacturing workers.

Subjects and Methods

Study participants

The present prospective study was carried out on a group of people who registered for health examinations in the Department of Occupational and Environmental Medicine at a university hospital and working at 23 small- to medium-sized manufacturing companies in the Incheon area. According to the Korean Industrial Safety and Health Act, workers are required to undergo health examinations on a regular basis. In 2009, a total of 3,572 workers were invited to fill out a self-reporting questionnaire that included personal and occupational characteristics and depressive symptoms. A second survey was conducted on the same workers from the same manufacturing companies in 2010, in which workers were asked to respond a self-reporting questionnaire on work absences. A total of 2,956 (82.8%) workers responded to the second survey. However, because of poor responses to depressive symptoms (more than four missing answers in the CES-D) and missing data on absence, 607 subjects were excluded. Thus, the analysis was conducted using the data of 2,349 subjects (1,807 males and 542 females). The study protocol was approved by the institutional review board of Inha University Hospital. All responders provided written informed consent.

Measurements

Depressive symptoms

Depressive symptoms were measured with the Korean version of the Center for Epidemiologic Studies Depression Scale (CES-D)[23]. The CES-D consists of 20 items that relate to symptoms and behaviors associated with depression; each item is scored on a scale from zero to four points; the total score range is 0–60. Cho and Kim[24] demonstrated the validity of the Korean version of the CES-D. In this previously study a score ≥16 was found to have good sensitivity and specificity for identifying those with depressive symptoms[25]. Thus, in the present study, we designated all participants with a CES-D score of ≥16 points as having depressive symptoms. In the analysis, depression scores were also treated as a continuous vari-

able. Since depression scores were skewed to the right, we divided the scores of the CES-D scale into quartiles in order to analyze linear associations between depressive symptoms and work absence. Median scores were 6 for men and 8 for women; interquartile ranges were 7 and 8, respectively.

Covariates

We also included several other potential confounding variables thought to be possibly associated with absence due to accident and illness. These potential confounders were selected based on the results of previous studies[26, 27]. Employees provided information on age (yr), gender (male and female), education (middle school or lower, high school, and university), marital status (unmarried, married, and widowed/divorced), and duration of daily sleep (h). Ages were divided into four ranges: under 30, 30–39, 40–49, and over 50, and the hours of sleep were divided into under 6, 6–8, and 9 or over. Occupational characteristics included type of employment (permanent vs. temporary), type of work (shift vs. non-shift), length of employment (under 1 yr, 1–4 yr, 5–9 yr, and 10 yr or over), and weekly work hours (40 h or under, 41–59 h, and 60 h or over). In addition, employees provided information about the presence of chronic diseases.

Absence due to accident and illness

The dependent variable was whether or not a worker had been absent from work because of an accident or illness during the past year. Those who responded "yes" to either (1) "Were absent from work because of any accident occurring at work in the past year?" or (2) "Were absent from work due to illness in the past year?" were included in the absence group.

Statistical analysis

The statistical analysis was conducted on men and women separately, because depressive symptoms and absence are known to be gender dependent. Differences in absence due to accident and illness over the previous 12 months according to the subjects' general and work-related characteristics and depressive symptoms were analyzed using a χ^2 test. In order to calculate the odds ratio (OR) of depressive symptoms for absence, we constructed several multivariable logistic regression models, following the estimation of crude effects. Model 1 was adjusted for age, marital status, and educational level. Model 2 was further adjusted for sleeping time, shift work, tenure, working hours, employment status, and chronic disease (diseases lasting at least 3 months). However, chronic disease was not included as a confounder in the analysis of female participants as they did not report such diseases.

The percentages of missing values within the analyzed population were <10% for occupational characteristics, <15% for marital status and education level, and 17% for daily sleeping hours. We used the Markov Chain Monte Carlo method, which assumes that variables with missing data are multivariate normal and missing at random, to impute missing values for covariates. This method has been shown to produce accurate results even when dichotomous variable data is missing[28]. Statistical significance was applied with a 95% confidence interval (CI), and data were analyzed using SPSS ver. 14.0 software (SPSS Inc., Chicago, IL, USA) and STATA 13.

Results

We first examined the relationship between depressive symptom level (CES-D continuous) and sickness absence (yes/no). The average CES-D scores for men and women that took sick leave were 8.40 (SD=6.99) and 13.37 (SD=10.28) for women, and the average CES-D scores for men and women that did not were 6.37 (SD=5.83) for men and 9.52 (SD=7.51) for women.

Table 1 compares the general and occupational characteristics and depressive symptoms of participants included in the analysis and those excluded. Significant differences were observed between these two groups in terms of age, educational level, and weekly working hours for men and women. However, no significant difference was found between these two groups in terms of employment status, sleeping duration, or depressive symptoms for men or women. Furthermore, no statistical significance was observed between men in the study group and exclusion group in terms of shift work, job tenure, or chronic diseases (Table 1).

General and occupational characteristics and absences due to accidents by gender are summarized in Table 2. Rates of absence during follow-up in men and women were 3% (n=55) and 2.4% (n=13), respectively. Among males, the proportion that took leave of absence due to accident was 14.7% greater for those with a middle school or lower level of education than for those educated to a high school or college level (p<0.001). The proportion that took leave of absence was also significantly higher for those that worked on average ≥60 h per week (9.1%) than among those that worked 41–59 h per week (3.1%, p<0.001). Likewise, a higher proportion of individuals

Table 1. Characteristics of the study subjects included and not included in the present study

	Male			Female		
	Included (N=1,807)	Excluded (N=373)*	*p*-value	Included (N=542)	Excluded (N=117)*	*p*-value
Age (yr)						
<30	198	21	<0.001	394	46	<0.001
30–39	714	97		109	21	
40–49	574	171		31	27	
≥50	321	84		8	23	
Marital status						
Never married	329	6	0.01	321	18	0.885
Married	1,215	56		171	9	
Divorced/widowed	20	3		4	0	
Educational status						
≤Middle school	34	7	<0.001	10	6	<0.001
High school	904	48		418	22	
≥College	611	9		64	0	
Sleeping time (h/d)						
<6	207	8	0.841	49	3	0.901
6–8	1,228	52		382	20	
≥9	32	2		61	4	
Chronic disease						
No	1,578	327	0.848	531	110	0.027
Yes	229	46		11	7	
Employment status						
Regular	1,635	78	0.189	486	19	0.120
Temporary	133	10		43	4	
Shift work						
No	752	26	0.126	48	5	0.033
Yes	951	48		482	17	
Job tenure (yr)						
<1	60	2	0.051	32	5	0.01
1–4	172	7		169	6	
5–9	351	8		223	5	
≥10	1,160	69		104	8	
Hours/week worked						
≤40	818	103	<0.001	148	12	0.011
41–59	710	18		364	8	
≥60	110	5		14	1	
Depressive symptoms						
No (CES-D <16)	1,689	35	0.250	440	15	0.106
Yes (CES-D ≥16)	118	5		102	8	

Total numbers may not be equal to the total included and excluded numbers for some characteristics due to missing data. *Of the 616 participants who were excluded, we considered 490 (373 for male and 117 for female) after removing 121 participants who included in the follow up but not reported their workplace absence.

with a career duration of less than 1 yr (8.3%) took leave of absence than those with careers of longer duration. In addition, a significant difference was found between shift and non-shift workers (4.2% and 1.7%, respectively; p=0.002). However, no significant difference in absence due to accidents was observed in male workers with respect to age, marital status, sleeping time, employment status or the presence of chronic disease. Regarding fe-

Table 2. General and occupational characteristics of participants with absence due to accidents according to gender

	Male				Female			
	N**	Cases of the absence		*p*-value†	N**	Cases of the absence		*p*-value†
		n*	%			n*	%	
Total	1,807	55	3.0		542	13	2.4	
Age (yr)								
<30	198	5	2.5	0.961	394	10	2.5	0.334
30–39	714	24	3.4		109	1	0.9	
40–49	574	16	2.8		31	2	6.5	
≥50	321	10	3.1		8	0	0.0	
Marital status								
Never married	329	13	4.0	0.603	321	11	3.4	0.313
Married	1,215	31	2.6		171	2	1.2	
Divorced/widowed	20	0	0.0		4	0	0.0	
Missing	243				46			
Educational status								
≤Middle school	34	5	14.7	<0.001	10	1	10.0	0.298
High school	904	29	3.2		418	11	2.6	
≥College	611	9	1.5		64	1	1.6	
Missing	258				50			
Sleeping time (h/d)								
<6	207	12	5.8	0.120	49	4	8.2	0.049
6–8	1,228	31	2.5		382	8	2.1	
≥9	32	0	0.0		61	1	1.6	
Missing	340				50			
Chronic disease								
No	1,578	41	2.6	0.131	531	13	2.4	
Yes	229	10	4.4		11	0	0.0	
Employment status								
Regular	1,635	48	2.9	0.411	486	10	2.1	0.081
Temporary	133	5	3.8		43	3	7.0	
Missing	39				13			
Shift work								
No	752	30	4.2	0.002	48	0	0.0	0.619
Yes	951	15	1.7		482	13	2.7	
Missing	103				12			
Job tenure (yr)								
<1	60	5	8.3	0.043	32	3	9.4	0.104
1–4	172	8	4.6		169	4	2.4	
5–9	351	10	2.8		223	5	2.2	
≥10	1,160	29	2.5		104	1	1.0	
Missing	63				14			
Hours/week worked								
≤40	818	16	2.0	0.001	148	3	2.0	0.419
41–59	710	22	3.1		364	8	2.2	
≥60	110	10	9.1		14	1	7.1	
Missing	168				16			

*The number of subjects experiencing absence due to accidents. **The number of participants. †Based on the χ^2 test or Fisher's Exact test.

Table 3. General and occupational characteristics of participants with absence due to illness according to gender

	Male				Female			
	N**	Cases of the absence		*p*-value†	N**	Cases of the absence		*p*-value†
		n*	%			n*	%	
Total	1,807	109	6.0		542	94	17.3	
Age (yr)								
<30	198	26	13.1	<0.001	394	79	20.1	0.048
30–39	714	53	7.4		109	11	10.1	
40–49	574	25	4.4		31	4	12.9	
≥50	321	5	1.6		8	0	0.0	
Marital status								
Never married	329	36	10.9	<0.001	321	67	20.9	0.019
Married	1,215	57	4.7		171	19	11.1	
Divorced/widowed	20	1	5.0		4	0/4	0.0	
Missing	243				46			
Educational status								
≤Middle school	34	1	2.9	0.784	10	0	0.0	0.058
High school	903	55	6.1		418	80	19.1	
≥College	610	33	5.4		64	6	9.4	
Missing	258				50			
Sleeping time (h/d)								
<6	207	23	11.1	0.018	49	12	24.5	0.449
6–8	1,228	70	5.7		382	62	16.2	
≥9	32	0	0.0		61	12	19.7	
Missing	340				50			
Chronic disease								
No	1,578	93	5.9	0.508	531	94	17.7	
Yes	229	11	4.8		11	0	0.0	
Employment status								
Regular	1,635	101	6.2	0.168	486	82	16.7	0.275
Temporary	133	4	3.0		43	10	23.3	
Missing	39				13			
Shift work								
No	753	50	6.6	0.198	48	4	8.3	0.088
Yes	951	49	5.2		482	88	18.3	
Missing	103				12			
Job tenure (yr)								
<1	60	8	13.3	<0.001	32	9	28.1	0.020
1–4	173	18	10.4		169	37	21.9	
5–9	351	28	8.0		223	36	16.1	
≥10	1,160	51	4.4		104	10	9.6	
Missing	63				14			
Hours/week worked								
≤40	818	43	5.3	0.134	148	20	13.5	0.483
41–59	711	54	7.5		364	67	18.4	
≥60	110	7	6.4		14	2	14.3	
Missing	168				16			

*The number of subjects experiencing absence due to illness. **The number of participants. †Based on the χ^2 test or Fisher's Exact test.

male participants, significant differences were found only for sleep duration; 8.2% took leave of absence in the ≤6 h group, which was a significantly higher proportion than in the other sleep duration groups (p=0.049) (Table 2).

Table 4. Odds ratio's (95% confidence intervals) for participants reporting depressive symptoms and the absence due to accidents or illness

Depressive symptoms	Male					Female				
	n*/N**	%	Unadjusted	Model 1	Model 2	n*/N**	%	Unadjusted	Model 1	Model 2
			OR (95% CI)	OR (95% CI)	OR (95% CI)			OR (95% CI)	OR (95% CI)	OR (95% CI)
Absence due to accident										
No (CES-D <16)	46/1,689	2.7	1.00	1.00	1.00	9/440	2.0	1.00	1.00	1.00
Yes (CES-D ≥16)	9/118	7.6	2.95 (1.41–6.18)	2.70 (1.28–5.70)	2.89 (1.33–6.27)	4/102	3.9	1.96 (0.59–6.48)	1.82 (0.53–6.23)	1.51 (0.41–5.64)
Per 1 point increase	55/1,807	3.0	1.08 (1.05–1.12)	1.08 (1.04–1.11)	1.08 (1.04–1.12)	13/542	2.4	1.06 (1.01–1.11)	1.06 (1.00–1.11)	1.05 (0.99–1.11)
Absence due to illness										
No (CES-D <16)	89/1,689	5.3	1.00	1.00	1.00	66/440	15.0	1.00	1.00	1.00
Yes (CES-D ≥16)	20/118	16.9	3.67 (2.17–6.21)	3.95 (2.28–6.84)	4.06 (2.32–7.11)	28/102	27.5	2.14 (1.29–3.56)	1.81 (1.07–3.05)	1.75 (1.02–2.98)
Per 1 point increase	109/1,807	6.0	1.05 (1.02–1.08)	1.06 (1.03–1.09)	1.06 (1.03–1.09)	94/542	17.3	1.05 (1.03–1.08)	1.04 (1.02–1.07)	1.04 (1.02–1.07)

*The number of subjects experiencing absence due to illness or accident. **The number of participants. Model 1 adjusted for age, marital status, and educational level. Model 2 adjusted for (1) and sleeping time, shift work, tenure, working hours, employment status, and chronic diseases. §Adjusted for age, educational status, sleeping time, shift work, tenure, working hours, marital status, and employment status. The model 2 was not adjusted for chronic diseases in the analyses of female participants.

Table 3 summarizes general and occupational characteristics and absences due to illness by gender. A total of 203 (8.6%) employees (n=109 (6%) men and n=94 (17.3%) women) were designated as having taken absence due to illness during the 1 yr follow up period; and sex differences were found to be significant (p<0.001) (data not shown). The proportion that took absence due to illness was significantly higher among subjects aged <30 yr (13.1% for men and 20.1% for women) than among other older age groups. With regard to marital status, a higher proportion of workers who were never married experienced absence due to illness (10.9% for men, p<0.001; 20.9% for women, p=0.048). Likewise, individuals with a career duration of <1 yr (13.3% for men, p<0.001; 28.1% for women, p=0.020) had a significantly higher rate of absence than those with a career of longer duration. Men who slept for <6 h daily were most likely to be absent from work, followed by men that slept for 6–8 h daily (p=0.018) (Table 3).

In a separate stratified analysis conducted by gender showed women were more like to be depressed than men (18.8% vs. 6.5%; p<0.001) (data not shown). Table 4 presents relationships between depressive symptoms and absences due to accidents or illness by gender. The percentages of workers scoring within the reference range of depressive symptoms (CES-D ≥16) and were absent from work due to illness were 16.9% for men and 27.5% for women. Men and women with depressive symptoms at baseline were found to be at increased odds of being absent due to illness at follow up. Unadjusted models showed a significant effect of depressive symptoms on the absence due to illness (OR=3.67; 95% CI: 2.17–6.21 for men and 2.14; 95% CI: 1.29–3.56 for women). OR's after adjustment for demographic factors were 3.95 (95% CI: 2.28–6.84) and 1.81 (95% CI: 1.07–3.05) for men and women, respectively. In male models, additional adjustment for the presence of chronic disease and occupational factors did not alter ORs considerably; ORs increased in size but remained significant (OR=4.06; 95% CI: 2.32–7.11). In female models, when additionally adjusted for occupational factors, ORs reduced in size but remained significant (OR=1.75; 95% CI: 1.02–2.98). Analyses of CES-D scores (when treated as a continuous variable) the adjusted OR for a 1 point increase in score was 1.06 (95% CI: 1.03–1.09) for men and 1.04 (95% CI: 1.02–1.07) for women.

When crude ORs were calculated for absence due to accidents, men with depressive symptoms showed statistically significant OR (2.95, 95% CI: 1.41–6.18), and after adjusting for confounders, the OR (2.89, 95% CI: 1.33–6.27) did not alter significantly. However, among female workers, crude and adjusted ORs were not significant. In the analysis of continuous CES-D scores, the ORs for unadjusted and adjusted models were significant for men and women, except for model 2 among women, which was marginally significant (p=0.09) (Table 4).

As shown in Table 5, significant ORs were observed for the fourth depressive symptom score quartile versus the first quartile for absence due to accidents in men (p for trend <0.001) but not in women. With regard to the absence due to illness, clear trends were observed for men and women, that is, higher ORs were observed mostly among employees with high levels of depressive symptoms (Table 5).

Table 5. Odds ratio's (95% confidence intervals) for depressive symptoms (in quartiles) and the absence due to accidents and illness

Depressive symptoms score in quartiles	Unadjusted		Model 1		Model 2	
	OR	95% CI	OR	95% CI	OR	95% CI
Absence due to accidents						
Male (N=1,807)*						
1st (low score)**	1.00		1.00		1.00	
2nd	2.49	0.86–7.21	2.46	0.85–7.15	2.40	0.82–7.07
3rd	2.59	0.88–7.63	2.59	0.87–7.66	2.46	0.82–7.42
4th	8.15	3.13–21.25	7.73	2.95–20.30	7.13	2.67–19.02
p for trend		<0.001		<0.001		<0.001
Female (N=542)***						
1st (low score)**	1.00		1.00		1.00	
2nd	2.17	0.36–13.17	2.00	0.33–12.34	1.92	0.29–12.61
3rd	1.43	0.20–10.31	1.34	0.18–9.77	1.23	0.16–9.25
4th	4.06	0.81–20.43	3.63	0.70–18.74	3.05	0.57–16.38
p for trend		0.094		0.058		<0.001
Absence due to illness						
Male (N=1,807)						
1st (low score)**	1.00		1.00		1.00	
2nd	0.94	0.53–1.68	0.92	0.51–1.65	0.86	0.47–1.56
3rd	1.08	0.60–1.94	1.30	0.72–2.35	1.18	0.64–2.15
4th	2.08	1.24–3.48	2.36	1.39–4.01	2.22	1.30–3.81
p for trend		0.004		<0.001		<0.001
Female (N=542)						
1st (low score)**	1.00		1.00		1.00	
2nd	1.80	0.91–3.55	1.84	0.93–3.65	1.89	0.95–3.79
3rd	1.80	0.91–3.55	1.84	0.93–3.65	1.77	0.89–3.55
4th	2.98	1.59–5.57	2.55	1.34–4.82	2.46	1.29–4.69
p for trend		0.001		0.935		0.036

*The cut points for quartiles for male models are: 1st quartile 0–2 (n=525), 2nd quartile 3–6 (n=471), 3rd quartile 7–9 (n=412), and 4th quartile 10–41 (n=399). **Low depression symptom score indicate few depressive symptoms (reference group).***The cut points for quartiles for female models are: 1st quartile 0–5 (n=171), 2nd quartile 6–8 (n=120), 3rd quartile 9–13 (n=120), and 4th quartile 14–50 (n=131). Model 1 adjusted for age, marital status, and educational level. Model 2 adjusted for (1) and sleeping time, shift work, tenure, working hours, employment status, and chronic diseases. The model 2 was not adjusted for chronic diseases in the analyses of female participants.

Discussion

In the present study, depressive symptoms at baseline were found to be prospectively associated with absence due to illness during the following year, and with absence due to accidents for men, but not for women. In women, depression score (analyzed as a continuous variable) was associated with the incidence of absence due to accidents, but the significance of this association was lost after adjustment for occupational characteristics. Associations between depressive symptoms and sickness absence were stronger and more consistent for men than for women, but the interaction term between depressive symptoms and gender was not statistically significant.

In the present study, the prevalences of depressive symptoms in men and women were 6.5% and 18.8%, respectively, and these rates agreed with those reported in other study based on nationwide community samples of Korean adults[5]. However, our reported prevalence rates are much lower than those reported by Park *et al*[21]. This difference may be caused by the use of different instruments for assessing depressive symptoms. Park *et al.* used the World Health Organization (WHO-5) wellbeing index, and most studies that used WHO-5 as a depression

measuring tool have reported higher prevalence rates than studies that used other measurements.

In this study, the incidence rate of absence due to illness was 6.0% for men and 17.3% for women, and these rates seem comparable with those reported in other study conducted in a Korean working population that assessed absenteeism using self-reports[15]. Nevertheless, rates of absence as determined in the present study appear lower than those reported in European countries. Findings from 31 countries in Europe showed that the rate of at least one absence day within the past 12 months was 22.2% for men and 25.7% for women[29], which is much higher than those found in the present study. The lower rate of absence in Korea may be due to the fact that employees are forced to work while sick because of job insecurity[15]. In addition, because employers are being forced to pay workers absent from work due to sickness or accident for a considerable time[30], employers may have motivated sick employees remain in work to reduce the cost of sickness absence.

Despite the different measures of depressive symptoms and methodologies used, our results regarding the magnitude of the effect of depressive symptoms on sickness absence compare reasonably well with those of previous prospective studies conducted on general populations[7, 9, 31]. Lexis *et al.*[9] studied the effect of depressive complaints (measured using HADS) on subsequent 10-month sickness absence in a working population, and obtained hazard ratios for men and women of 1.57 and 1.36, respectively, for moderate to severe complaints. These findings concur with our results of higher ORs in those workers with high levels of depressive symptoms (OR=2.22 for men and 2.46 for women). It has been shown a significant correlation between CES-D and HADS scores (r=0.50, p<0.001)[32]. Bültmann *et al.*[31] identified severe depressive symptom score of ≤52 points on the Mental Health Inventory (MHI-5) scale as a risk factor of long-term sickness absence in a working population. Laitinen-Krispijn and Bijl[7] prospectively studied associations between different forms of mental disorders with sickness absence over a 1 yr follow up. A multivariate model showed that drug abuse or dependence was most strongly associated with sickness absence in men, with an OR of 3.83 (95% CI: 1.55–9.48). Drug abuse is closely associated with depression[33], and in the present study, we observed significant odds of sickness absence in both men (OR=4.06; 95% CI: 2.32–7.11) and women (OR=1.75; 95% CI: 1.02–2.98). Some differences in the magnitudes of effects of depressive symptoms on sickness absence can be expected, as definitions of sickness absence and the depression scales used vary.

In the present study, we observed significant odds of sickness absence in workers with in the highest quartile of the depression scale, indicating that the absence occurred mainly in those workers with high levels of depressive symptoms. Insignificant ORs in the lower quartile (2nd and 3rd) CES-D scales may indicate mild depression in higher distress scores in our study population. However, further study of a large number of cases is needed to confirm this possibility. Regarding absence due to accidents, ORs for the relationships between depressive symptoms and absence were in the expected direction only for male workers, except for unadjusted and model (model 1), in which depression was treated as a continuous variable. We attribute this gender-associate difference to the small number of women with depressive symptoms.

We found male workers showed a stronger association between depressive symptoms and absence than female workers, which agrees with the findings of other studies[7, 34]. The reasons for these gender differences are not understood, but may be due to more effective help seeking behavior by women[35] and a different propensities to report psychiatric symptoms by gender[36]. For women, ORs were reduced in model 2, which suggested non-occupational factors (model 1) may be more influential in depressed women with respect to taking absence than in depressed men. It should be considered the effect of differential health selection according to gender in our study, leaving healthy female workers from their job, but this appears unlikely as overall rates of absence and depressive symptoms were higher in women than in men. Moreover, in the present study, more than 75% of the study population were men and there is no obvious health selection by gender. However, other studies found no gender difference with respect to the risk of absence due to depression[8, 37].

The strengths of this study are its prospective design, which minimized misclassifications of CES-D scores and absences, and the control of potential confounders in the analysis. However, the study has several limitations that warrant consideration. First, we adopted a self-reported questionnaire to measure absence from work, and respondents may have exhibited recall bias. Although the use of recorded absence data rather than self-reported absence seems to be an asset, one study showed a moderate to high correlation exists between self-reported and recorded absences[38]. Second, we used a binary variable to identify whether a worker has been absent from work at least once during the 12-month follow-up period, whereas in the majority of previous studies, number of days of absence during the previous year have been used. Third,

our analyses included participants who had participated in both rounds of the survey; those who only took part in the first round were not included. Possible differences in characteristics of participants due to the exclusion might have biased the results although we did not find statistically significance differences in CES-D measured at baseline between the participants included in the analysis and those excluded. Fourth, the study subjects were limited to manufacturing workers who registered for a health examination in a single large hospital, and thus, our findings may not be applicable to other workers. Finally, we did not account for unmeasured confounders, such as, income, access to health insurance, and the availability of paid sick leave. The association between depressive symptoms and absence according to educational level (an indicator of socioeconomic status) was examined. However, the differences in ORs according to levels of education were not consistent and not large enough to provide significant effect modification.

Conclusions

This prospective study suggests manufacturing workers with depressive symptoms (as measured using the CES-D scale) are more likely to take absence due to illness or accidents. Workplace absenteeism is an important issue that merits continued attention and management, as it has implications for employee health and safety, and imposes direct costs on employers. We suggest additional studies be undertaken to examine the effects of stress, anxiety, and working conditions on sickness absence among workers with depression.

Author Contributions

Y.S.H. and H.C.K. conceived, designed, and performed the research; and D.K.L. and H.C.K. analyzed data and wrote the paper.

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Conflicts of Interest

The authors have no conflict of interest to declare.

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