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 employees1, and account for one-third of all new disability benefits among the Organization for Economic Cooperation and Development (OECD) member nations5. In particular, depression is one of the costliest of health conditions in terms of disability, treatment, and indirect costs3. 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 nature4. 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 20095. Depression imposes a substantial economic burden on Korean society, and in 2005 this was estimated to be $4,049 million6.

Many previous studies have reported prospective associations between depressive symptoms and sickness absence7–12. A Dutch study conducted on a working population of 3,339 showed a significant association...
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)$^{10}$. 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. 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 χ² 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. 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
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 1. Characteristics of the study subjects included and not included in the present study

| Characteristic                     | Male Included (N=1,807) | Male Excluded (N=373)* | Male p-value | Female Included (N=542) | Female Excluded (N=117)* | Female 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.
### 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 χ² 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).

|                          | Male |                     | Female |                     |
|--------------------------|------|---------------------|--------|---------------------|
|                          | N**  | Cases of the absence | p-value$^1$ | N**  | Cases of the absence | p-value$^1$ |
|                          | 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 | 0.0 | 50 | 0.0 |
| 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 | 0.0 | 50 | 0.0 |
| 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 | 0.0 | 50 | 0.0 |
| 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 | 0.0 | 13 | 0.0 |
| 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 | 0.0 | 12 | 0.0 |
| 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 | 0.0 | 14 | 0.0 |
| 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 | 0.0 | 16 | 0.0 |

*The number of subjects experiencing absence due to illness. **The number of participants. $^1$Based on the $\chi^2$ test or Fisher’s Exact test.
the absence due to illness (OR=3.67; 95% CI: 2.17–6.21) showed a significant effect of depressive symptoms on absence due to illness at follow up. Unadjusted models at baseline were found to be at increased odds of being absent due to illness for women. Men and women with depressive symptoms from work due to illness were 16.9% for men and 27.5% of depressive symptoms (CES-D ≥16) and were absent from work, followed by men that slept for 6–8 h daily who slept for <6 h daily were most likely to be absent (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: 1.02–3.05) 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: 1.03–1.08) 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 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 4. Odds ratio’s (95% confidence intervals) for participants reporting depressive symptoms and the absence due to accidents or illness

| Depressive symptoms | Male | Female |
|---------------------|------|--------|
|                     | Unadjusted | Model 1 | Model 2 | Unadjusted | Model 1 | Model 2 |
| 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 | 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) | 3.9 1.96 (0.59–6.48) 1.82 (0.53–6.23) 1.51 (0.41–5.64) | 1.05 (0.99–1.11) |
| Per 1 point increase| 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 | 28/102 27.5 2.14 (1.29–3.56) 1.81 (1.07–3.05) 1.75 (1.02–2.98) |
| 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) | 2.82 (1.07–3.05) 1.75 (1.02–2.98) |
| Per 1 point increase| 10/1,807 6.0 1.05 (1.02–1.08) 1.06 (1.03–1.09) 1.06 (1.03–1.09) 1.06 (1.00–1.11) 1.06 (1.00–1.11) |

*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. 1Adjusted 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.
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

Discussion

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).**

**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.
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. 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, 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. In addition, because employers are being forced to pay workers absent from work due to sickness or accident for a considerable time, 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. 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 ($r=0.50$, $p<0.001$). 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. 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, 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. Insufficient 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. The reasons for these gender differences are not understood, but may be due to more effective help seeking behavior by women and a different propensities to report psychiatric symptoms by gender. 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.

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. 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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