

Research Article



A study of job stress, suicidal ideation and suicide attempts in display manufacturing workers: a cross-sectional study

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Abbreviations

BMI: body mass index; CES-D: Center for Epidemiologic Studies Rating Scale for Depression; CI: confidence interval; HR:

ABSTRACT

Background: This study aimed to investigate the association between job stress and suicide ideation/attempts among display manufacturing workers.

Methods: Data were collected from 836 workers in a display manufacturing company who participated in health screenings from May 22 to June 16, 2017. The data included general characteristics, night work, job tenure, previous physician-diagnosed chronic diseases, suicidal ideation/suicide attempts, and job stress. We investigated suicidal ideation/suicide attempts that covered the past year by using a self-reported questionnaire. Job stress was measured using the 43-item Korean Occupational Stress Scale. Multiple logistic regression analysis was used to investigate the association between job stress and suicidal ideation/suicide attempts. The mediator effect of depression on suicidal ideation/suicide attempts was tested using a series of logistic regression by applying Baron and Kenny's mediation method.

Results: In the model adjusting for variables (e.g., age, body mass index, smoking, alcohol consumption, regular exercise, shift work, job tenure, chronic disease and depression), physical environment (OR: 3.60, 95% CI: 1.08–12.02), lack of reward (OR: 5.31, 95% CI: 1.54–18.34), and occupation climate (OR: 7.36, 95% CI: 2.28–23.72) were correlated with suicidal ideation/suicide attempts in women. However, all subscales of job stress were not significantly correlated with suicidal ideation/suicide attempts in men. In mediation analysis, job instability and occupational climate were correlated with suicidal ideation/suicide attempts and were mediated by depression in men workers.

Conclusions: In women workers, the experiences of suicidal ideation/suicide attempts were significantly correlated with the physical environment, lack of reward, and occupational climate that were subscales of job stress. In men workers, depression rather than job stress was correlated with experiences of suicidal ideation/suicide attempts.

Keywords: Suicidal ideation; Suicide attempt; Job stress; Occupational stress; Manufacturing sector workers

BACKGROUND

World widely, nearly 800,000 people die each year from suicide, and many more people attempt to commit suicide [1]. In Korea, suicide was the fourth leading cause of death in

hazard ratio; KOSS: Korean Occupational Stress Scale; OR: odds ratio; SD: standard deviation.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

Data will not be shared to ensure the protection of personal information.

Author Contributions

Conceptualization: Ahn SH; Data curation: Ahn SH, Ryu SH, Lee YJ, Jang EC, Kwon SC, Min YS; Formal analysis: Ahn SH, Ryu SH, Lee YJ, Jang EC, Kwon SC, Min YS; Investigation: Ahn SH, Ryu SH; Writing - original draft: Ahn SH; Writing - review & editing: Lee YJ.

2017, accounting for 24.3 deaths per 100,000 people [2]. The same report stated that among Korean people aged 20 to 39 years, suicide is the first leading cause of death [2].

The National Institute for Occupational Safety and Health defines job stress as the “harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker” [3]. A study conducted in Korea showed that increased occupational stress increases depressive symptoms, and that reduced occupational stress decreases depressive symptoms [4]. In a study of Norwegian police officers, the lack of support and work injuries, among the subscales of job stress, are shown to be associated with depression [5]. Major depression is known to be one of the most important risk factors for suicide [6,7].

Numerous personal factors, such as young age, being a woman, unmarried status, underweight, and low education level, are reported as risk factors for suicidal ideation [8-11]. Factors related to the work environment, including precarious employment, high workplace stress, long working hours, night or shift work, bullying behaviors, and burnout, are also reported as risk factors for suicide [12-16].

Several previous studies have reported that job stress is associated with suicidal ideation in specific occupations. High emotional demands correlated with increased suicidal ideation in Korean service and sales workers [17]. Insufficient job control and lack of reward correlated with increased suicidal ideation among Korean subway drivers [18]. Job stress correlated with increased suicidal ideation in Taiwanese female nurses [19]. A recent degrading experience or harassment at work correlated with recent suicidal ideation in Swedish surgeons [20]. However, no study has explored the relation between job stress and suicide ideation/attempts in display manufacturing workers. This study aimed to investigate the relation between job stress and suicidal ideation/suicide attempts among Korean display manufacturing workers.

METHODS

Participants

This study adopted a cross-sectional design. The participants were 19 to 39-year-old workers in a display manufacturing company who participated in a health checkup and agreed to fill out a questionnaire at a university hospital in Cheonan, Chungcheongnam-do, between May 22 and June 16, 2017. A total of 838 participants were enrolled; 2 were excluded for providing insufficient response. Data from the final 836 participants were used in the study.

Assessment of occupational stress

The Korean Occupational Stress Scale (KOSS) was developed to assess job stress in the working population in Korea [21]. KOSS consists of 43 items in 8 subscales: physical environment, job demand, insufficient job control, interpersonal conflict, job insecurity, organizational system, lack of reward, and occupational climate. Each item is scored using a 4-point Likert scale. Total job stress score of KOSS and 8 subscale scores were calculated using a 100-point system. In a study that assessed the reliability and validity of KOSS, KOSS showed high validity and correlation with the Mental Fatigue Scale, short form of the Psychosocial Wellbeing Index, and Job Content Questionnaire. The internal reliability of the subscale was assessed using Cronbach's alpha and scored from 0.512 to 0.822 [21]. We divided the participants into high- and low-occupational stress groups depending on

whether they scored above or below the 75th percentile of the KOSS reference value (top 25% of Korean workers' scores).

Assessment of suicidal ideation/suicide attempts

Suicidal ideation and suicide attempts were assessed using the self-reported questions "Have you ever thought of dying in the last year?" and "Have you ever attempted suicide in the last year?", respectively. The response was reported as either "Yes" or "No." Participants who answered yes to either question were classified as having suicidal ideation/suicide attempts.

Assessment of depression

We assessed depression and severity using the Center for Epidemiologic Studies Rating Scale for Depression (CES-D). CES-D consists of 20 items related to the characteristic symptoms of depression. Each item is scored using a 4-point Likert scale. An outcome of 21 points or more was classified as a depression [22].

Other variables

A self-reported questionnaire was used to collect the following information: sex, age, body mass index (BMI), exercise, smoking, alcohol consumption, shift work history, job tenure, previous physician-diagnosed chronic diseases (e.g., hypertension, diabetes mellitus, dyslipidemia, stroke, heart disease). BMI was classified as " $\geq 25 \text{ kg/m}^2$ " and " $< 25 \text{ kg/m}^2$." Alcohol consumption was classified as "non-drinker," "1–2 times per week," and "3 times or more per week." Smoking was classified as "current smoker," "past smoker," and "non-smoker." Exercise was classified as "do not exercise," "1–2 times every week," "3 times or more per week." Shift work was classified as "not do shift work" and "do shift work." Job tenure was classified as "less than 5 years," "5 years or more but less than 10," "10 years or more but less than 15," and "15 years or more." Chronic diseases were classified as having one or more of hypertension, diabetes, dyslipidemia, stroke, and heart disease diagnosed by a doctor.

Statistical analyses

According to the experience of suicidal ideation/suicide attempt, the participants were classified into 2 groups. Characteristics of participants were analyzed using χ^2 test and Fisher's exact/Fisher–Freeman–Halton test. Logistic regression analysis was performed to investigate the relation between job stress and suicidal ideation/suicide attempts. In a crude model, data for job stress were entered as an independent variable, and suicidal ideation/suicide attempts as a dependent variable. In model 1, general characteristics (age, BMI, smoking, alcohol consumption, regular exercise), and chronic diseases were adjusted by entering covariates. In model 2, general characteristics (age, BMI, smoking, alcohol consumption, regular exercise), occupational characteristics (shift work, job tenure) and chronic diseases were adjusted by entering covariates. In model 3, general characteristics (age, BMI, smoking, alcohol consumption, regular exercise), occupational characteristics (shift work, job tenure), chronic diseases, and CES-D were adjusted by entering covariates. Sex differences have been found in the relation between job stress and suicidal ideation [23–26]. Therefore, in all our regression models, all data were stratified by sex. The mediator effect of depression on suicidal ideation/suicide attempts was tested using a series of logistic regression by applying Baron and Kenny's mediation method. A mediator effect of depression was tested when there is a significant relation between subscale of job stress and suicidal ideation/suicide attempts and a significant relation between depression and suicidal ideation/suicide attempts. In the first step, suicidal ideation/suicide attempts (the dependent variable) was regressed on subscale of job stress (the independent variable). In the

second step, depression (the mediator variable) was regressed on subscale of job stress (the independent variable). In the third step, suicidal ideation/suicide attempts (the dependent variable) was regressed on the depression (the mediator variable). In the final step, suicidal ideation/suicide attempts (the dependent variable) was regressed on depression (the mediator variable) and subscale of job stress (the independent variable). A mediator effect of depression is supported when the significant association between the subscale of job stress (the independent variable) and suicidal ideation/suicide attempts (the dependent variable) becomes less significant or nonsignificant when both subscale of job stress (the independent variable) and depression (the mediator variable) are entered in the regression model. Results were presented as odds ratio (OR) with 95% confidence intervals (CIs), and *p*-values of less than 0.05 were considered statistically significant. Statistical analyses were performed with SPSS 25.0 (IBM Corp., Armonk, NY, USA).

Ethics statement

This retrospective study was approved by the Institutional Review Board (IRB) of Soonchunhyang University Hospital, Cheonan (IRB No. 2019-01-013-002), and informed consent was waived.

RESULTS

Table 1 shows the differences in suicidal ideation/suicide attempts by general characteristics, occupational characteristics, chronic diseases, and depression. Experience of suicidal ideation/suicide attempts was 3.90% in men and 9.47% in women. In men only, the proportion of CES-D \geq 21 was significantly higher in the suicidal ideation/suicide attempts group. Meanwhile, we found no statistically significant results in the other variables.

Table 2 lists the KOSS score, KOSS reference value (75th percentile), and the number and proportion of participants classified as high risk. The total job stress score of KOSS was 53.33 ± 8.55 in men and 55.63 ± 8.31 in women. In men, insufficient job control scored 67.29 ± 11.36 . Insufficient job control was reported by 68.1% of the men participants classified as high risk, the highest among the other subscales. In women, interpersonal conflict scored 54.97 ± 16.00 . Interpersonal conflict was reported by 78.1% of women participants classified as high risk, the highest among the other subscales.

Tables 3 and 4 show the relation between job stress and suicidal ideation/suicide attempts in men and women, respectively. In the crude model, job insecurity (OR: 2.94, 95% CI: 1.29–6.69) and occupational climate (OR: 3.16, 95% CI: 1.33–7.51) correlated with increased suicidal ideation/suicide attempts in men, whereas physical environment (OR: 3.80, 95% CI: 1.30–11.12), lack of reward (OR: 5.17, 95% CI: 1.73–15.44), and occupational climate (OR: 6.58, 95% CI: 2.24–19.32) correlated with increased suicidal ideation/suicide attempts in women.

In model 1, after adjusting for age, BMI, smoking, alcohol consumption, regular exercise, and chronic diseases, job insecurity (OR: 2.85, 95% CI: 1.24–6.53) and occupational climate (OR: 2.89, 95% CI: 1.19–7.00) correlated with increased suicidal ideation/suicide attempts in men, whereas physical environment (OR: 3.57, 95% CI: 1.15–11.10), lack of reward (OR: 5.47, 95% CI: 1.71–17.52), and occupational climate (OR: 7.55, 95% CI: 2.37–23.99) correlated with increased suicidal ideation/suicide attempts in women.

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Table 1. Distribution of workers with suicidal ideation/suicide attempts by characteristics (n = 836)

Characteristics	Men (n = 667)			Women (n = 169)		
	Without SI/SA	With SI/SA	p-value	Without SI/SA	With SI/SA	p-value
Age (years)			0.753			0.581
< 25	26 (100.0)	0 (0.0)		43 (91.5)	4 (8.5)	
25–29	19 (95.0)	1 (5.0)		37 (88.1)	5 (11.9)	
30–34	195 (96.5)	7 (3.5)		44 (88.0)	6 (12.0)	
35–39	401 (95.7)	18 (4.3)		29 (90.5)	1 (9.5)	
BMI (kg/m ²)			0.167			0.749
< 25	335 (97.1)	10 (2.9)		121 (91.0)	12 (9.0)	
≥ 25	306 (95.0)	16 (5.0)		32 (88.9)	4 (11.1)	
Regular exercise (times/week)			0.439			0.241
0	211 (95.0)	11 (5.0)		70 (86.4)	11 (13.6)	
1–2	299 (96.1)	12 (3.9)		56 (94.9)	3 (5.1)	
≥ 3	131 (97.8)	3 (2.2)		27 (93.1)	2 (6.9)	
Smoking			0.180			0.204
Non-smoker	247 (94.6)	14 (5.4)		146 (91.3)	14 (8.8)	
Past smoker	135 (95.7)	6 (4.3)		2 (66.7)	1 (33.3)	
Current smoker	259 (97.7)	6 (2.3)		5 (83.3)	1 (16.7)	
Alcohol consumption (times/week)			0.812			0.467
0	108 (96.4)	4 (3.6)		58 (87.9)	8 (12.1)	
1–2	397 (95.7)	18 (4.3)		82 (93.2)	6 (6.8)	
≥ 3	136 (97.1)	4 (2.9)		13 (86.7)	2 (13.3)	
Chronic disease			0.586			1.000
No	545 (96.3)	21 (3.7)		146 (90.1)	16 (9.9)	
Yes	98 (95.1)	5 (4.9)		7 (100.0)	0 (0.0)	
Job tenure			0.388			1.000
< 5	33 (97.1)	1 (2.9)		23 (92.0)	2 (8.0)	
5–9	154 (93.9)	10 (6.1)		70 (89.7)	8 (10.3)	
10–14	421 (96.8)	14 (3.2)		56 (90.3)	6 (9.7)	
≥ 15	33 (97.1)	1 (2.9)		4 (100.0)	0 (0.0)	
Shift work			0.687			0.413
No	247 (96.5)	9 (3.5)		64 (92.8)	5 (7.2)	
Yes	394 (95.9)	17 (4.1)		89 (89.0)	11 (11.0)	
CES-D (score)			< 0.001 ^a			0.156
0–20	630 (97.1)	19 (2.9)		141 (91.6)	13 (8.4)	
21–60	11 (61.1)	7 (38.9)		12 (80.0)	3 (20.0)	

Values are presented as number (%).

SI: suicidal ideation; SA: suicide attempt; BMI: body mass index; CES-D: Center for Epidemiologic Studies Rating Scale for Depression.

The p-value by χ^2 or Fisher's exact test/Fisher-Freeman-Halton test; ^ap < 0.05.

Table 2. Job stress levels of the participants (n = 836)

Subscales	Men (n = 667)			Women (n = 169)		
	Mean ± SD	Reference ^a	High risk participants	Mean ± SD	Reference ^a	High risk participants
Physical environment	45.26 ± 14.67	66.7	69 (10.3)	42.38 ± 13.90	55.6	33 (19.5)
Job demand	42.01 ± 11.47	58.4	64 (9.6)	43.09 ± 12.73	62.6	12 (7.1)
Insufficient job control	67.29 ± 11.36	60.1	454 (68.1)	73.07 ± 10.65	66.7	123 (72.8)
Interpersonal conflict	53.89 ± 14.82	50.1	328 (49.2)	54.97 ± 16.00	41.7	132 (78.1)
Job insecurity	57.51 ± 10.00	61.2	268 (40.2)	58.32 ± 10.21	55.6	98 (58.0)
Organizational system	64.45 ± 14.45	62.0	369 (55.3)	68.64 ± 14.29	62.0	118 (69.8)
Lack of reward	58.37 ± 14.05	77.8	62 (9.3)	63.63 ± 13.37	77.8	27 (16.0)
Occupational climate	37.90 ± 12.69	50.1	87 (13.0)	40.92 ± 15.47	50.1	34 (20.1)
Total job stress score	53.33 ± 8.55	56.6	240 (36.0)	55.63 ± 8.31	56.7	80 (57.3)

Values are presented as number (%).

SD: standard deviation.

^aKorean Occupational Stress Scale reference value (75th percentile).

In model 2, after adjusting for age, BMI, smoking, alcohol consumption, regular exercise, shift work, job tenure, and chronic diseases, job insecurity (OR: 3.07, 95% CI: 1.32–7.13) and occupational climate (OR: 3.14, 95% CI: 1.28–7.72) correlated with increased suicidal

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Table 3. ORs and 95% CIs for suicidal ideation/suicide attempts according to job stress in men (n = 667)

Subscales	Crude			Model 1			Model 2			Model 3		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Physical environment	2.15	0.78–5.89	0.138	2.22	0.79–6.24	0.131	2.27	0.79–6.48	0.127	1.39	0.42–4.61	0.594
Job demand	1.76	0.59–5.28	0.313	1.47	0.47–4.61	0.507	1.89	0.58–6.17	0.291	0.73	0.17–3.24	0.682
Insufficient job control	1.60	0.63–4.02	0.327	1.60	0.63–4.09	0.326	1.48	0.54–4.04	0.446	1.14	0.39–3.32	0.805
Interpersonal conflict	2.00	0.88–4.56	0.098	1.79	0.78–4.12	0.171	1.82	0.79–4.22	0.161	1.30	0.53–3.20	0.567
Job insecurity	2.94	1.29–6.69	0.010 ^a	2.85	1.24–6.53	0.014 ^a	3.07	1.32–7.13	0.009 ^a	2.35	0.96–5.74	0.061
Organizational system	1.55	0.68–3.53	0.296	1.40	0.61–3.24	0.427	1.42	0.61–3.31	0.413	0.96	0.39–2.41	0.936
Lack of reward	2.44	0.89–6.72	0.084	2.38	0.85–6.72	0.100	2.49	0.88–7.06	0.087	0.68	0.16–2.92	0.600
Occupational climate	3.16	1.33–7.51	0.009 ^a	2.89	1.19–7.00	0.019 ^a	3.14	1.28–7.72	0.013 ^a	2.00	0.72–5.51	0.183

Crude: unadjusted; Model 1: adjusted for age, BMI, smoking, alcohol consumption, regular exercise, chronic disease; Model 2: adjusted for age, BMI, smoking, alcohol consumption, regular exercise, chronic disease, shift work, job tenure; Model 3: adjusted for age, BMI, smoking, alcohol consumption, regular exercise, chronic disease, shift work, job tenure, CES-D.

OR: odds ratio; CI: confidence interval; BMI: body mass index; CES-D: Center for Epidemiologic Studies Rating Scale for Depression.

^ap < 0.05.

Table 4. ORs and 95% CIs for suicidal ideation/suicide attempts according to job stress in women (n = 169)

Subscales	Crude			Model 1			Model 2			Model 3		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Physical environment	3.80	1.30–11.12	0.015 ^a	3.57	1.15–11.10	0.028 ^a	3.74	1.13–12.36	0.031 ^a	3.60	1.08–12.02	0.037 ^a
Job demand	3.69	0.89–15.35	0.072	3.44	0.78–15.08	0.102	3.68	0.81–16.64	0.091	3.23	0.67–15.61	0.145
Insufficient job control	2.83	0.62–12.95	0.181	2.72	0.53–13.98	0.232	2.75	0.50–15.11	0.245	2.45	0.44–13.81	0.309
Interpersonal conflict	2.08	0.45–9.58	0.349	1.92	0.40–9.11	0.414	1.94	0.41–9.28	0.405	1.83	0.38–8.85	0.451
Job insecurity	1.67	0.55–5.04	0.363	1.89	0.60–5.92	0.278	1.88	0.60–5.91	0.278	1.74	0.54–5.58	0.350
Organizational system	3.30	0.72–15.08	0.124	3.61	0.75–17.30	0.108	3.62	0.75–17.61	0.111	3.41	0.69–16.86	0.133
Lack of reward	5.17	1.73–15.44	0.003 ^a	5.47	1.71–17.52	0.004 ^a	5.43	1.68–17.56	0.005 ^a	5.31	1.54–18.34	0.008 ^a
Occupational climate	6.58	2.24–19.32	0.001 ^a	7.55	2.37–23.99	0.001 ^a	7.64	2.39–24.38	0.001 ^a	7.36	2.28–23.72	0.001 ^a

Crude: unadjusted; Model 1: adjusted for age, BMI, smoking, alcohol consumption, regular exercise, chronic disease; Model 2: adjusted for age, BMI, smoking, alcohol consumption, regular exercise, chronic disease, shift work, job tenure; Model 3: adjusted for age, BMI, smoking, alcohol consumption, regular exercise, chronic disease, shift work, job tenure, CES-D.

OR: odds ratio; CI: confidence interval; BMI: body mass index; CES-D: Center for Epidemiologic Studies Rating Scale for Depression.

^ap < 0.05.

ideation/suicide attempts in men, whereas physical environment (OR: 3.74, 95% CI: 1.13–12.36), lack of reward (OR: 5.43, 95% CI: 1.68–17.56), and occupational climate (OR: 7.64, 95% CI: 2.39–24.38) correlated with increased suicidal ideation/suicide attempts in women.

In model 3, after adjusting by adding CES-D to the model 2 variables, no statistically significant variables were seen in men, but in women, physical environment (OR: 3.60, 95% CI: 1.08–12.02), lack of reward (OR: 5.31, 95% CI: 1.54–18.34), and occupation climate (OR: 7.36, 95% CI: 2.28–23.72) still correlated with increased suicidal ideation/suicide attempts.

Table 5 shows the results of mediation analysis to confirm that depression acts as a mediator in the relationship between subscales of job stress and suicidal ideation/suicide attempts. Job insecurity and occupational climate among the subscales of job stress in men workers were included as independent variables in the mediation analysis. In step 1, job insecurity (OR: 2.94, 95% CI: 1.29–6.69) and occupational climate (OR: 3.16, 95% CI: 1.33–7.51) correlated with increased suicidal ideation/suicide attempts. In step 2, job insecurity (OR: 5.44, 95% CI: 1.77–16.72) and occupational climate (OR: 5.77, 95% CI: 2.21–15.06) correlated with depression. In step 3, depression climate (OR: 21.10, 95% CI: 7.37–60.40) correlated with increased suicidal ideation/suicide attempts. In step 4, job insecurity and occupational climate showed no significant relationship with suicidal ideation/suicide attempts whereas depression still showed significant relationship with suicidal ideation/suicide attempts, thus demonstrating a mediator role for depression.

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Table 5. Logistic regression results by steps in the mediation analysis (n = 667)

Independent variables		Dependent variable	B	SE	OR	95% CI	p-value
Independent variables: job insecurity (in men)							
Step 1	Job insecurity	Suicidal ideation/suicide attempts	1.077	0.420	2.94	1.29–6.69	0.010 ^a
Step 2	Job insecurity	Depression	1.694	0.573	5.44	1.77–16.72	0.003 ^a
Step 3	Depression	Suicidal ideation/suicide attempts	3.049	0.537	21.10	7.37–60.40	< 0.001 ^a
Step 4	Job insecurity	Suicidal ideation/suicide attempts	0.787	0.442	2.20	0.92–5.23	0.075
	Depression		2.802	0.552	16.47	5.58–48.65	< 0.001 ^a
Independent variables: occupational climate (in men)							
Step 1	Occupational climate	Suicidal ideation/suicide attempts	1.151	0.442	3.16	1.33–7.51	0.009 ^a
Step 2	Occupational climate	Depression	1.753	0.489	5.77	2.21–15.06	< 0.001 ^a
Step 3	Depression	Suicidal ideation/suicide attempts	3.049	0.537	21.10	7.37–60.40	< 0.001 ^a
Step 4	Occupational climate	Suicidal ideation/suicide attempts	0.722	0.493	2.06	0.78–5.41	0.143
	Depression		1.834	0.554	6.26	2.12–18.53	< 0.001 ^a

B: unstandardized beta coefficients; SE: standard error; OR: odds ratio; CI: confidence interval.

^ap < 0.05.

DISCUSSION

We examined the differences in suicidal ideation/suicide attempts by general characteristics, occupational characteristics, chronic diseases, and depression among display manufacturing workers, and the correlation between suicidal ideation/suicide attempts and the subscales of job stress.

Our study found that 5.02% of the total, 3.90% of the men, and 9.47% of the women display manufacturing workers experienced suicidal ideation/suicide attempts. In a study of the general population in Korea in 2018, 3.6% of individuals aged 19 to 29 years and 3.8% of individuals aged 30 to 39 years had suicidal ideation within the past year [27]. The experience of suicidal ideation in our study was higher than these results. Meanwhile, several studies have reported a higher prevalence of suicidal ideation and attempts in women [24–26]. These results are consistent with our finding that women had more experiences of suicidal ideation/suicide attempts than men.

In a study of surgeons in Korea, the total job stress score of KOSS was 50.0 ± 8.0 in men and 55.3 ± 10.1 in women [28]. Although direct comparisons are difficult given the differences in age distribution, our results showed that manufacturing workers have higher total job stress, measured by KOSS, compared with surgeons. Indeed, several studies have reported that job stress is associated with suicidal ideation in specific occupational groups. High emotional demands (OR: 1.98, 95% CI: 1.14–3.45 in men; OR: 1.86, 95% CI: 1.26–2.73 in women) are associated with suicidal ideation in Korean service and sales workers [17]. Insufficient job control (OR: 2.215, 95% CI: 1.017–4.736) and lack of reward (OR: 2.236, 95% CI: 1.021–5.153) are associated with suicidal ideation among Korean subway drivers [18]. Job stress (OR: 2.7, 95% CI: 2.2–3.3), personal burnout (OR: 3.8, 95% CI: 3.1–4.6), and client-related burnout (OR: 3.9, 95% CI: 3.1–5.0) are associated with suicidal ideation in Taiwanese female nurses [19]. Among work-related factors, a recent degrading experience or harassment at work (OR: 2.83, 95% CI: 1.13–7.09) is related to recent suicidal ideation in Swedish surgeons [20]. As such, the factors of job stress affecting suicidal ideation are different across occupation groups.

In our study, job instability and occupational climate correlated with increased risk of suicidal ideation/suicide attempts in men workers in the crude model, model 1 and model 2. However, we found no correlation between job stress and suicidal ideation/suicide attempts in model 3, which adjusted model 2 with the addition of CES-D. Mediation analysis confirmed

that job instability and occupational climate increased suicidal ideation/suicide attempts in men workers and were mediated by depression. In women workers, the physical environment, lack of reward, and occupational climate increased the risk of suicidal ideation/suicide attempts in the crude model, model 1, model 2 and model 3. These results suggested that the physical environment, lack of reward, and occupational climate directly affected suicidal ideation/suicide attempts in women workers. In women workers, insufficient job control, interpersonal conflict, job insecurity, and organizational system scored higher than the KOSS reference (75th percentile), but did not correlate with suicidal ideation/suicide attempts. The overall stress level in these subscales of job stress was high, so the difference in job stress level between the high-risk group and the low-risk group may be small. Hence, the 2 groups may have homogeneous characteristics. Physical environment, lack of reward, and occupational climate showed relatively low job stress scores, but correlated with suicidal ideation/suicide attempts. This may be due to the relatively large gap of job stress level between the high-risk group and the low-risk group, thereby the 2 groups may have different characteristics.

In a hospital cohort study of Korean employees using the Korean Occupational Stress Scale-Short Form, job stress is reported as increasing the risk of suicidal ideation [29]. In young men aged 18 to 35 years, high job demands (hazard ratio [HR]: 1.22, 95% CI: 1.05–1.41), lack of reward (HR: 1.33, 95% CI: 1.12–1.59), and discomfort in the organizational climate (HR: 1.34, 95% CI: 1.16–1.56) are associated with suicidal ideation. In young women aged 18 to 35 years, organizational injustice (HR: 1.26, 95% CI: 1.01–1.58), and discomfort in the organizational climate (HR: 1.42, 95% CI: 1.18–1.70) are associated with suicidal ideation [29]. The finding that discomfort in the organizational climate increases the risk of suicidal ideation in young women workers is consistent with our results. However, the relation between suicidal ideation and the subscales of job stress, except for discomfort in the organizational climate, was inconsistent with our results. This may be caused by differences in the participants' occupational characteristics, adjusted variables, and statistical analysis methods.

Women report more fatigue than men [30,31]. Chua et al. [32] found that when workers feel uncomfortable in their physical environment, they tend to be tired and stressed easily, leading to unethical behavior. This explanation may be applied to our findings that the job stress from the physical environment raised the risk of suicidal ideation/suicide attempts in women display manufacturing workers. In this display manufacturing company, both men and women workers carried out glass transportation, glass cutting, and placement of 40 kg films. These physical tasks may have caused more fatigue for women than for men. Thus, women may be more vulnerable than men to the effects of job stress arising from the work environment on suicidal ideation/suicide attempts.

Moreover, high effort reward imbalance in women is associated with increased risk of suicidal ideation, but not in men [33]. This result was similar to our findings. A previous study suggested the following possible explanation for the findings: the differences in the level of effort and reward in women are larger compared with men [33]. Women may experience various unmeasured pressures, such as multiple tasks outside work, and social discrimination, which may interact with the effort reward imbalance and influence the occurrence of suicidal ideation [33]. A study of men subway workers in Korea has reported that the lack of reward increases the risk of suicidal ideation [18]. This result was inconsistent with our findings. This mismatch might be caused by differences in the working environment of the 2 groups. The display manufacturing company in the present study used a performance-based salary system in which a higher position means a higher salary and a

higher rate of pay for performance. Owing to the gap in job tenure after women use parental leave, men are more likely to be promoted than women, which may lead to wage gaps. This gap might explain women's job stress the lack of reward.

In the women workers in the present study, the finding that occupational climate, which is subscale of job stress, increased the risk of suicidal ideation/suicide attempts could be explained in the context of the Korean working culture. In such a culture, discomfort in the occupational climate can be reflected in the post-work dinners, non-standard or inconsistent work order, authoritative and vertical atmosphere, and gender discrimination. The characteristics of the occupational climate, such as the Korean collectivist culture, irrational communication system, and informal workplace culture can act as stressors [21]. Compared with Western organizations, Korean companies may have a more hierarchical and authoritarian atmosphere under the influence of collectivism and Confucianism [34,35]. Workers may feel so pressured as to experience suicidal ideation if personality, rationality, and gender equality are ignored in the workplace [29]. In the display manufacturing company in the present study, when workers produce LCD glass substrates, the alkali component should not enter the glass substrate to avoid problems in the stability of the panel [36]. Therefore, workers are expected to perform precise work. In addition, workers must wear personal protective equipment for safety, as they may be exposed to various chemicals at work. Because of the high level of technology used in the production of displays, workers must also take steps to prevent the leakage of technology. These several measures are extremely important and must be performed. Thus, in the course of carrying out these measures, a rigorous work atmosphere may be formed, which may affect suicidal ideation/suicide attempts.

This study has several strengths. First, it is the first study on job stress and suicidal ideation/suicide attempts among young display manufacturing workers. This study identified the subscales of job stress that influenced suicidal ideation/suicide attempts in young display manufacturing workers, which have hardly been investigated. Second, depression, one of the most important risk factors of suicide, was adjusted in this study. Third, this study analyzed data stratified by sex, thereby revealing sex differences in the relation between job stress and suicidal ideation/suicide attempts.

As for limitations, the present study had the following. First, because we used a cross-sectional design, we could not establish the causality of association between job stress and suicide ideation/suicide attempts in display manufacturing workers. Second, this study used only self-reported data, and as such, response bias could have distorted the results. Although standardized self-reported health data can be used as valid measures of health in epidemiologic research and population health monitoring, responses may change because of respondents' personal circumstances or methodological processes [37,38]. Third, missing variables might have skewed our results. As the data were based on health screening data, other risk factors for suicidal ideation/suicide attempts, such as marital status, education level, income level, employment status, working hours, and burnout, were not investigated [10-16,39]. Thus, the possibility of residual confounding effects cannot be ruled out.

CONCLUSIONS

The experiences of suicidal ideation/suicide attempts were correlated with not only depression but also job stress in young display manufacturing workers aged 19 to 39 years.

In women workers, these experiences were significantly correlated with the physical environment, lack of reward, and occupational climate, which are subscales of job stress. In men workers, depressive symptoms correlated with increased suicidal ideation/suicide attempts, and job stress did not affect suicidal ideation/suicide attempts.

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