

Original Article



# Correlation of commute time with the risk of subjective mental health problems: 6<sup>th</sup> Korean Working Conditions Survey (KWCS)

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## ABSTRACT


**Background:** Studies conducted so far on the link between commute time and mental health among Koreans remain insufficient. In this study, we attempted to identify the relationship between commute time and subjective mental health using the 6<sup>th</sup> Korean Working Conditions Survey (KWCS).

**Methods:** Self-reported commute time was divided into four groups: ≤ 30 (group 1), 30–60 (group 2), 60–120 (group 3), and > 120 minutes (group 4). Subjective depression was defined as a score of 50 points or less on the WHO-5 well-being index. Subjective anxiety and fatigue were defined as answering ‘yes’ to the questionnaire on whether they had experienced it over the past year. The analysis of variance, *t*-test, and  $\chi^2$  test was used to analyze the differences among the characteristics of the study participants according to commute time, depression, anxiety, and fatigue. Odds ratios (ORs) and 95% confidence intervals (CIs) for depression, anxiety, and fatigue according to commute time were calculated using multivariate logistic regression models adjusted for sex, age, monthly income, occupation, company size, weekly working hours, and shift work status.

**Results:** Long commute times showed increased ORs and graded increasing trends for depression, anxiety, and fatigue. The ORs for depression increased significantly in group 2 (1.06 [1.01–1.11]), group 3 (1.23 [1.13–1.33]), and group 4 (1.31 [1.09–1.57]) compared to group 1 (reference). The ORs for anxiety increased significantly in group 2 (1.17 [1.06–1.29]), group 3 (1.43 [1.23–1.65]) and group 4 (1.89 [1.42–2.53]). The ORs for fatigue increased significantly in group 2 (1.09 [1.04–1.15]), group 3 (1.32 [1.21–1.43]), and group 4 (1.51 [1.25–1.82]).

**Conclusions:** This study highlights that the risk of depression, anxiety, and fatigue increases with commute time.


**Keywords:** Commute time; Subjective mental health; Depression; Anxiety; Fatigue; 6<sup>th</sup> Korean Working Conditions Survey

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### Abbreviations

CI, confidence interval; HPA, hypothalamic-pituitary-adrenal; IRB, Institutional Review Board; KWCS, Korean Working Conditions Survey; OR, odds ratio.

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### Competing interests

The authors declare that they have no competing interests.

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## BACKGROUND

Most workers, except for telecommuters, commute daily. The method and time of commuting varies depending on the situation of the workers. Commute has many effects on individual well-being, because it is regular and repetitive.<sup>1,2</sup> Satisfaction with commute considerably impacts overall happiness.<sup>3</sup>

Commute time tends to inevitably increase because of the growth of cities and increase in suburban residency caused by rising housing prices.<sup>4,5</sup> According to data from Statistics Korea, the average Korean commute time in 2020 was approximately 61.6 min per round trip per day—a slight increase from 55 minutes in 2005.<sup>5</sup> This is the longest commute time among OECD countries, and it is more than twice the OECD average.<sup>6</sup>

Long commutes have various adverse effects on workers. For example, long commute times can increase the risk of sleep disorders<sup>7,8</sup> and mental problems,<sup>9,13</sup> such as mental strain, depression, anxiety, and fatigue. Workers with longer commute times complain of more subjective health symptoms<sup>14</sup> and their productivity is lower than that of workers with shorter commutes.<sup>15</sup>

Mental health is an important factor for individual well-being, and its importance has recently been emphasized. Many studies have examined the relationship between commute time and mental health. A study conducted at 10 epidemiological investigation centers in South America found that the risk of depression increased by 0.5 percent as commute time increased by 10 minutes.<sup>9</sup> A retrospective cohort study in Australia showed a decrease in the Mental Health Inventory score for individuals commuting for more than 6 hours compared to those who commute less than 2 hours a week.<sup>10</sup> In the United States, the longer the commute, the higher is the blood concentration of cortisol, a stress hormone.<sup>16</sup> Other cross-sectional studies have also reported that commute time adversely affects subjective mental health.<sup>11</sup>

However, previous studies did not consider shift work status that could affect mental health<sup>17,18</sup> and had relatively small sample sizes. In addition, although depression, anxiety, and fatigue are common mental health problems,<sup>19,20</sup> comprehensive studies on the relationship between commute time and these mental health problems in Korea are insufficient. Therefore, this study attempted to investigate the correlation of commute time with the risk of subjective mental health problems using the 6<sup>th</sup> Korean Working Conditions Survey (KWCS).

## METHODS

### Study participant

This study was conducted based on data from the 6<sup>th</sup> KWCS. The KWCS investigates the overall work environment, including the form of work, employment pattern, type of occupation and business, exposure to risk factors, and job stability. The KWCS has been conducted every three years since 2006, and the 6<sup>th</sup> KWCS was conducted from October 2020 to April 2021.

First, we selected 43,413 out of 50,538 workers, excluding telecommuters, workers under four days a week, and those under 20 years of age. Among them, participants who answered “I don’t know,” “no answer,” or “reject” following questionnaire were excluded: commute time,

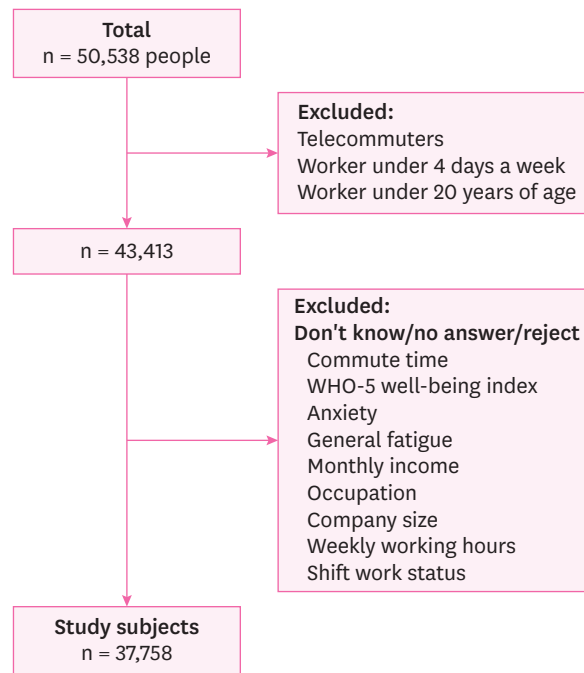


Fig. 1. Diagram showing the process of selecting study subjects.

WHO-5 well-being index, anxiety, general fatigue, monthly income, occupation, company size, weekly working hours and shift work status. Finally, data from 37,758 workers were analyzed (Fig. 1).

### Definition of main variables

Self-reported commute times were divided into four groups:  $\leq 30$  (group 1), 30–60 (group 2), 60–120 (group 3), and  $> 120$  minutes (group 4). The commute time includes a daily round trip per day. Subjective depression was defined as a score of 50 points or less on the WHO-5 well-being index.<sup>21</sup> Subjective anxiety and general fatigue were defined as answering 'yes' to the questionnaire on whether they had experienced it over the past year.

### Covariates

Age was divided into five groups: 20–29, 30–39, 40–49, 50–59, and  $\geq 60$  years. The monthly income was divided into four groups:  $< 2$ , 2–3, 3–4,  $\geq 4$  million Korean Won (KRW). According to the Korean Standard Classification of Occupations in the 6<sup>th</sup> KWCS, the occupations of the study population were divided into 11 types: We divided the occupations of the study participants into three categories: white collar workers (managers, professions occupation, clerical occupation), pink collar workers (service occupation, sales occupation) and blue collar workers (craft and related occupation, plant and machine operatives, other occupations in agriculture, forestry and fishing, other elementary occupation) Based on the number of workers, the company was divided into three groups:  $< 50$ , 50–300,  $\geq 300$  workers. Based on their responses, shift work status was classified as yes or no. Weekly working hours was presented as the average value.

### Statistical analysis

The analysis of variance, *t*-test, and  $\chi^2$  test was used to analyze the differences among the characteristics of the study participants according to commute time, depression, anxiety, and

fatigue. Data are expressed as numbers (percentage) for categorical variables and as means  $\pm$  standard deviation for continuous variable.

Odds ratios (ORs) and 95% confidence intervals (CIs) for depression, anxiety, and fatigue according to commute time were calculated using multivariate logistic regression models adjusted for sex, age, monthly income, occupation, company size, weekly working hours, and shift work status.

All statistical analyses were performed using IBM SPSS (version 19 for Windows; IBM Corp., Armonk, NY, USA), and a  $p$ -value  $< 0.05$  was considered statistically significant.

### Ethics statement

The Institutional Review Board (IRB) of Kyung Hee University Hospital approved the study protocol and data analysis (IRB File No. KHUH 2022-05-022). The IRB eliminated the requirement for informed consent because the researchers used a de-identified database retrospectively for the current study.

## RESULTS

The baseline characteristics of the commute time groups are shown in **Table 1**. Data from 37,758 workers (17,871 men and 19,887 women) were analyzed. Men, workers in their thirties and forties, high-income workers, white collar workers, workers at companies with more than 300 employees, shift workers had long commute times. The longer the commute time, the less the average weekly working hours.

The baseline characteristics of individuals with and without depression, anxiety, and fatigue are shown in **Table 2**. 12,363 of 37,758 workers had depression, 2,135 had anxiety, and 9,982 had fatigue. Workers over the age of 50, low-income workers, blue collar workers, workers at companies with less than 50 employees, and shift workers had more depression. Workers over the age of 30, workers at companies with more than 300 employees, and shift workers had more anxiety. Women, workers over the age of 50, low-income workers, blue collar workers, workers at companies with less than 50 employees, and shift workers had more fatigue. Workers with mental health problems such as depression, anxiety, and fatigue had longer average weekly working hours.

The ORs and 95% CIs of the multivariate logistic regression models for depression, anxiety, and fatigue according to commute time are shown in **Table 3**. In all cases, long commute times showed significantly increased ORs and a graded increasing trend in relation to depression, anxiety, and fatigue. The ORs for depression increased significantly in group 2 (OR: 1.06; 95% CI: 1.01–1.11), group 3 (OR: 1.23; 95% CI: 1.13–1.33), and group 4 (OR: 1.31; 95% CI: 1.09–1.57) compared to group 1 (reference). The ORs for anxiety increased significantly in group 2 (OR: 1.17; 95% CI: 1.06–1.29), group 3 (OR: 1.43; 95% CI: 1.23–1.65) and group 4 (OR: 1.89; 95% CI: 1.42–2.53). The ORs for fatigue increased significantly in group 2 (OR: 1.09; 95% CI: 1.04–1.15), group 3 (OR: 1.32; 95% CI: 1.21–1.43) and group 4 (OR: 1.51; 95% CI: 1.25–1.82).

In the stratification analyses by sex, the ORs for depression increased significantly in group 2 (OR: 1.08; 95% CI: 1.01–1.16), group 3 (OR: 1.39; 95% CI: 1.23–1.56), and group 4 (OR: 1.48; 95% CI: 1.11–1.97) in women. The ORs for anxiety increased significantly in group 3 (OR:

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**Table 1.** Comparison of baseline characteristics among groups with varying commute times (n = 37,758)

Characteristics	Total	Commute time (minutes)				p-value
		Group 1 (≤ 30 minutes) (n = 20,778)	Group 2 (30–60 minutes) (n = 12,645)	Group 3 (60–120 minutes) (n = 3,749)	Group 4 (> 120 minutes) (n = 586)	
Sex						< 0.001
Male	17,871 (47.33)	8,956 (50.11)	6,326 (35.40)	2,219 (12.42)	370 (2.07)	
Female	19,887 (52.67)	11,822 (59.45)	6,319 (31.77)	1,530 (7.69)	216 (1.09)	
Age (years)						< 0.001
20–29	3,590 (9.51)	1,834 (51.09)	1,289 (35.91)	403 (11.23)	64 (1.78)	
30–39	7,191 (19.04)	3,259 (45.32)	2,782 (38.69)	997 (13.86)	153 (2.13)	
40–49	8,958 (23.72)	4,349 (48.55)	3,346 (37.35)	1,078 (12.03)	185 (2.07)	
50–59	9,837 (26.05)	5,576 (55.68)	3,277 (33.31)	855 (8.69)	129 (1.31)	
≥ 60	8,182 (21.67)	5,760 (70.40)	1,951 (23.85)	416 (5.08)	55 (0.67)	
Household monthly income <sup>a</sup> (KRW)						< 0.001
< 2,000,000	10,410 (27.57)	7,147 (68.66)	2,634 (25.30)	556 (5.34)	73 (0.70)	
2,000,000–3,000,000	12,591 (33.35)	6,841 (54.33)	4,364 (34.66)	1,217 (9.67)	169 (1.34)	
3,000,000–4,000,000	8,386 (22.21)	4,114 (49.06)	3,125 (37.26)	989 (11.79)	158 (1.88)	
≥ 4,000,000	6,371 (16.87)	2,676 (42.00)	2,522 (39.59)	987 (15.49)	186 (2.92)	
Occupational classification						< 0.001
White collar workers	13,978 (37.02)	5,724 (40.95)	5,628 (40.26)	2,217 (15.86)	409 (2.93)	
Pink collar workers	11,479 (30.40)	7,483 (65.19)	3,311 (28.84)	616 (5.37)	69 (0.60)	
Blue collar workers	12,301 (32.58)	7,571 (61.55)	3,706 (30.13)	916 (7.45)	108 (0.88)	
Company size						< 0.001
< 50 workers	29,214 (77.37)	17,591 (60.21)	9,047 (30.97)	2,275 (7.79)	301 (1.03)	
50–300 workers	4,468 (11.83)	1,754 (39.26)	1,869 (41.83)	717 (16.05)	128 (2.86)	
≥ 300 workers	4,076 (10.80)	1,433 (35.16)	1,729 (42.42)	757 (18.57)	157 (3.85)	
Weekly working hours (hours)	43.13 ± 11.87	43.48 ± 13.32	42.91 ± 10.11	42.17 ± 9.05	41.70 ± 7.08	< 0.001
Shift work status						< 0.001
Yes	2,447 (6.48)	1,344 (50.39)	894 (35.88)	183 (11.73)	26 (2.00)	
No	35,311 (93.52)	19,434 (61.54)	11,751 (30.13)	3,566 (7.40)	560 (0.92)	

Categorical data presented as number (%); continuous data presented as mean ± standard deviation.

KRW = Korean won.

<sup>a</sup>2 million KRW = 1,559 US dollars, 3 million KRW = 2,338 US dollars, 4 million KRW = 3,118 US dollars.

1.35; 95% CI: 1.11–1.66), and group 4 (OR: 1.72; 95% CI: 1.17–2.53) in men, and in group 2 (OR: 1.21; 95% CI: 1.05–1.38), groups 3 (OR: 1.49; 95% CI: 1.21–1.84) and group 4 (OR: 2.09; 95% CI: 1.34–3.26) in women. The ORs for fatigue increased significantly in groups 2 (OR: 1.09; 95% CI: 1.01–1.18), group 3 (OR: 1.25; 95% CI: 1.12–1.40), and group 4 (OR: 1.36; 95% CI: 1.06–1.73) in men, and in groups 2 (OR: 1.08; 95% CI: 1.01–1.16), group 3 (OR: 1.38; 95% CI: 1.22–1.56), and group 4 (OR: 1.70; 95% CI: 1.27–2.30) in women. In all cases except depression in men, the multivariate adjusted model showed a significantly graded relationship between commute time and depression, anxiety, and fatigue.

## DISCUSSION

This large cross-sectional study highlights that long commute time is significantly associated with depression, anxiety, and fatigue. These results are consistent with previous studies. Wang et al.<sup>9</sup> found that the risk of depression increased by 0.5 percent as commute time increased by 10 minutes. Milner et al.<sup>10</sup> showed a decrease in the Mental Health Inventory score for individuals commuting for more than 6 hours compared to those who commute less than 2 hours a week. Murphy et al.<sup>11</sup> have also reported that commute time adversely affects subjective mental health. These results suggest that an increase in commute time has adverse effect on workers' mental health and implicate that reducing commute time can contribute to improving workers' mental health.

## Correlation of commute time with the mental health

**Table 2.** Comparison of baseline characteristics between individuals with non-mental health problem and mental health problem (n = 37,758)

Characteristics	Total	Non-depression (n = 25,395)	Depression (n = 12,363)	p-value	Non-anxiety (n = 35,623)	Anxiety (n = 2,135)	p-value	Non-fatigue (n = 27,776)	Fatigue (n = 9,982)	p-value
Sex				0.052			0.798			< 0.001
Male	17,871 (47.33)	11,973 (67.00)	5,898 (33.00)		16,893 (94.53)	978 (5.47)		13,420 (75.09)	4,451 (24.91)	
Female	19,887 (52.67)	13,422 (67.49)	6,465 (32.51)		18,730 (94.18)	1,157 (5.82)		14,356 (72.19)	5,531 (27.81)	
Age (years)				< 0.001			< 0.001			< 0.001
20–29	3,590 (9.51)	2,705 (75.35)	885 (24.65)		3,447 (96.02)	143 (3.98)		3,010 (83.84)	580 (16.16)	
30–39	7,191 (19.04)	5,176 (71.98)	2,015 (28.02)		6,773 (94.19)	418 (5.81)		5,663 (78.75)	1,528 (21.25)	
40–49	8,958 (23.72)	6,265 (69.94)	2,693 (30.06)		8,422 (94.02)	536 (5.98)		6,640 (74.12)	2,318 (25.88)	
50–59	9,837 (26.05)	6,561 (66.70)	3,276 (33.30)		9,264 (94.18)	573 (5.82)		6,979 (70.95)	2,858 (29.05)	
≥ 60	8,182 (21.67)	4,688 (57.30)	3,494 (42.70)		7,717 (94.32)	465 (5.68)		5,484 (67.03)	2,698 (32.97)	
Household monthly income <sup>a</sup> (KRW)				< 0.001			0.322			< 0.001
< 2,000,000	10,410 (27.57)	6,184 (59.40)	4,226 (40.60)		9,824 (94.37)	586 (5.63)		7,469 (71.75)	2,941 (28.25)	
2,000,000–3,000,000	12,591 (33.35)	8,661 (68.79)	3,930 (31.21)		11,903 (94.54)	688 (5.46)		9,373 (74.44)	3,218 (25.56)	
3,000,000–4,000,000	8,386 (22.21)	5,927 (70.68)	2,459 (29.32)		7,915 (94.38)	471 (5.62)		6,181 (73.71)	2,205 (26.29)	
≥ 4,000,000	6,371 (16.87)	4,623 (72.56)	1,748 (27.44)		5,981 (93.88)	390 (6.12)		4,753 (74.60)	1,618 (25.40)	
Occupational classification				< 0.001			0.064			< 0.001
White collar workers	13,978 (37.02)	10,247 (73.31)	3,731 (26.69)		13,137 (93.98)	841 (6.02)		11,013 (78.79)	2,965 (21.21)	
Pink collar workers	11,479 (30.40)	7,761 (67.61)	3,718 (32.39)		10,851 (94.53)	628 (5.47)		8,400 (73.18)	3,079 (26.82)	
Blue collar workers	12,301 (32.58)	7,387 (60.05)	4,914 (39.95)		11,635 (94.59)	666 (5.41)		8,363 (67.99)	3,938 (32.01)	
Company size				< 0.001			< 0.001			0.002
< 50 workers	29,214 (77.37)	19,253 (65.90)	9,961 (34.10)		27,647 (94.64)	1,567 (5.36)		21,369 (73.15)	7,845 (26.85)	
50–300 workers	4,468 (11.83)	3,137 (70.21)	1,331 (29.79)		4,201 (94.02)	267 (5.98)		3,365 (75.31)	1,103 (24.69)	
≥ 300 workers	4,076 (10.80)	3,005 (73.72)	1,071 (26.28)		3,775 (92.62)	301 (7.38)		3,042 (74.63)	1,034 (25.37)	
Weekly working hours (hours)	43.13 ± 11.87	42.80 ± 11.16	43.81 ± 13.19	< 0.001	43.06 ± 11.83	44.34 ± 12.41	< 0.001	42.55 ± 11.37	44.74 ± 13.02	< 0.001
Shift work status				0.004			0.010			< 0.001
Yes	2,447 (6.48)	1,620 (66.20)	827 (33.80)		2,280 (93.18)	167 (6.82)		1,712 (69.96)	735 (30.04)	
No	35,311 (93.52)	23,775 (67.33)	11,536 (32.67)		33,343 (94.43)	1,968 (5.57)		26,064 (73.81)	9,247 (26.19)	

Categorical data presented as number (%); continuous data presented as mean ± standard deviation.

KRW = Korean won

<sup>a</sup>2 million KRW = 1,559 US dollars, 3 million KRW = 2,338 US dollars, 4 million KRW = 3,118 US dollars.

**Table 3.** Odds ratios and 95% confidence intervals of depression, anxiety, and fatigue according to commute time in both sex group

Commute time (minutes)	Overall (n = 37,758)		Male (n = 17,871)		Female (n = 19,887)	
	Unadjusted	Multivariate adjusted	Unadjusted	Multivariate adjusted	Unadjusted	Multivariate adjusted
<b>Depression</b>						
Group 1 (≤ 30 minutes)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Group 2 (30–60 minutes)	0.90 (0.86–0.94)	1.06 (1.01–1.11)	0.87 (0.82–0.94)	1.02 (0.95–1.10)	0.92 (0.86–0.98)	1.08 (1.01–1.16)
Group 3 (60–120 minutes)	0.95 (0.88–1.02)	1.23 (1.13–1.33)	0.86 (0.78–0.95)	1.10 (0.99–1.22)	1.07 (0.96–1.20)	1.39 (1.23–1.56)
Group 4 (> 120 minutes)	0.95 (0.88–1.02)	1.31 (1.09–1.57)	0.85 (0.68–1.07)	1.17 (0.93–1.48)	1.10 (0.83–1.46)	1.48 (1.11–1.97)
p for linear trend	0.003	< 0.001	< 0.001	0.045	0.799	< 0.001
<b>Anxiety</b>						
Group 1 (≤ 30 minutes)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Group 2 (30–60 minutes)	1.16 (1.06–1.28)	1.17 (1.06–1.29)	1.09 (0.95–1.26)	1.12 (0.97–1.30)	1.24 (1.09–1.41)	1.21 (1.05–1.38)
Group 3 (60–120 minutes)	1.42 (1.24–1.63)	1.43 (1.23–1.65)	1.32 (1.09–1.60)	1.35 (1.11–1.66)	1.57 (1.28–1.93)	1.49 (1.21–1.84)
Group 4 (> 120 minutes)	1.92 (1.44–2.55)	1.89 (1.42–2.53)	1.72 (1.17–2.51)	1.72 (1.17–2.53)	2.29 (1.49–3.53)	2.09 (1.34–3.26)
p for linear trend	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
<b>Fatigue</b>						
Group 1 (≤ 30 minutes)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Group 2 (30–60 minutes)	0.96 (0.92–1.01)	1.09 (1.04–1.15)	1.00 (0.93–1.08)	1.09 (1.01–1.18)	0.95 (0.89–1.02)	1.08 (1.01–1.16)
Group 3 (60–120 minutes)	1.05 (0.97–1.13)	1.32 (1.21–1.43)	1.06 (0.95–1.18)	1.25 (1.12–1.40)	1.10 (0.98–1.24)	1.38 (1.22–1.56)
Group 4 (> 120 minutes)	1.14 (0.95–1.37)	1.51 (1.25–1.82)	1.10 (0.87–1.39)	1.36 (1.06–1.73)	1.32 (0.99–1.75)	1.70 (1.27–2.30)
p for linear trend	0.446	< 0.001	0.285	< 0.001	0.310	< 0.001

Multivariate adjusted model: adjusted for sex, age, monthly income, occupation, company size, weekly working hours, and shift work status.

The adverse effects of long commute times on workers' mental health can be divided into psychological and physiological causes. A long commute time can reduce the quality of life by reducing the time for family, and leisure activities, such as exercise and hobbies, and it can make workers depressed.<sup>10,22</sup> And long commute time can cause insufficient sleep and

sleep disorders,<sup>8</sup> and these sleep problems can be associated with fatigue,<sup>23</sup> anxiety and depression.<sup>24,25</sup> It also reduces the time to recover from daily stress and may be wasted, which can adversely affect workers' mental health.<sup>10,26</sup>

Dysfunction of the hypothalamic-pituitary-adrenal (HPA) axis can be considered a physiological mechanism. Salivary cortisol increases as commute time increases, and this increased cortisol in the body can cause HPA axis dysfunction, which is associated with depression.<sup>16,27</sup> In addition, workers are exposed to traffic noise while commuting, which adversely affects their mental health.<sup>28</sup>

In Korea, long commute time is intertwined with various and complex social issues. In 2022, 50.5% of Korea's population lives in the Seoul metropolitan area (Seoul, Gyeonggi, Incheon), which is 11.8% of the total land area, an increase of 3.4% from 47.1% in 2002.<sup>29,30</sup> This population structure concentrated in the Seoul metropolitan area can cause traffic jams by increasing population density, which can cause long commute times.<sup>31</sup> In fact, 62.0% of workers outside the Seoul metropolitan area had less than 60 minutes of commute time on a round trip a day, while only 35.9% in the Seoul metropolitan area.<sup>32</sup> And due to the high housing prices in Korea's metropolitan cities, especially in Seoul, deciding where to live far away from work is also a reason for the long commute.<sup>33</sup> In 2018, 37.9% of the total population in the Seoul metropolitan area lived in Seoul, while the proportion of workers in Seoul accounted for 45.5%, indicating that there was a severe job-housing imbalance between central cities and suburbs.<sup>29,33,34</sup> In addition, in Korea, children's education is an important factor influencing the choice of residential location, and migration to excellent school districts can worsen the job-housing imbalance and cause long commute time.<sup>35,36</sup>

In our results, women's commute time was shorter than men's, but women's mental health was more adversely affected by long commute time than men's. Women complained of more depression as the commute time increased, and statistically significant, but men did not. Both men and women complained of more anxiety and fatigue as the commute time increased and were statistically significant, but it was found that women were more affected. Roberts et al.<sup>37</sup> suggested that women are more sensitive to commute time because of their greater responsibility for daily household duties (such as childcare and housework). Even though gender roles in families have undergone significant change, women are still perceived as being largely responsible for household duties.<sup>8</sup> Women consider these household duties when making decisions about commute. In addition, repeated stops for duties like childcare pick-up and drop-off and grocery shopping during the commute increase the stress of commute by imposing greater time restrictions and reducing time flexibility.<sup>37</sup>

In this study, shift workers complained of more depression, anxiety, and fatigue. These results are consistent with those of previous studies. A meta-analysis of seven longitudinal studies found that shift work increases the overall risk of adverse mental health outcomes. In particular, shift workers had a 33% higher risk of experiencing depressive symptoms than non-shift workers.<sup>17</sup> A review of 23 studies suggests that the effects of shift work on mental health include sleep disorders, increased depression and anxiety, increased suicidal thoughts and substance abuse, cognitive decline, and the resulting dissatisfaction with overall life.<sup>18</sup>

The strength of this study is that as far as we know, it was the first try in Korea to investigate the relationship between worker's commute time and comprehensive mental health. This study was conducted using KWCS data that can represent general workers in Korea. In

addition, we considered shift work status that can affect mental health,<sup>17,18</sup> which was not mentioned in previous studies.

This study had several limitations. First, because this was a cross-sectional study, it was difficult to determine a causal relationship. Second, it was not possible to consider the psychiatric histories of the study participants. Third, since it is a self-administered questionnaire, the possibility that information on commute time, depression, anxiety, and fatigue was incorrectly collected cannot be excluded. Fourth, commute means and traffic congestion, known to affect mental health in previous studies, could not be considered. Previous studies have shown a significant difference in the stress experienced by workers depending on the means of commute.<sup>11</sup> Active commuting with exercise, such as walking and cycling, has a positive effect on mental health, including depression.<sup>38</sup> On the other hand, commuting by car or public transportation had adverse impact on mental health, and the impact was greater when there was a traffic jam.<sup>9</sup>

## CONCLUSIONS

We identified a significant correlation between workers' commute time and subjective mental health status in Korea. These results suggest that reducing commute time can improve workers' mental health. However, long commute time are associated with various and complex social issues. Comprehensive policies are needed on excessive population density and rising housing prices in the metropolitan areas, and educational imbalances between regions.

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