Industrial Health 2024, **62**, 133–142

Original Article

Association between commuting time and work-related low back pain with respect to sports and leisure activities in Korean workers

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Received July 10, 2023 and accepted September 28, 2023
Published online in J-STAGE November 7, 2023
DOI https://doi.org/10.2486/indhealth.2023-0100

Abstract: Long commuting times can induce work-related low back pain (LBP), which can be exacerbated by reduced sports and leisure activities. However, there is a lack of empirical research on commuting time and work-related LBP in Korea. In this study, we aimed to investigate the relationship between commuting time and work-related LBP as well as the effect of sports and leisure activities on Korean workers. We utilized data from the sixth Korean Working Conditions Survey to analyze the relationship between commuting time and work-related LBP using multivariable logistic regression. The total number of included workers was 28,202. Workers without sports and leisure activities, and long commuting times (40–59, 60–79, and ≥80 min) showed significantly higher odds ratios for work-related LBP (1.29 [95% Confidence intervals=1.12–1.49], 1.42 [1.22–1.65], and 1.96 [1.68–2.28], respectively). However, in workers with sports and leisure activities, the results were significant only for commuting times of 60–79 and ≥80 min (1.41 [1.13–1.75], 1.60 [1.28–1.99], respectively). Long commuting times were associated with work-related LBP, and engagement in sports and leisure activities was found to play a role in mitigating the impact among Korean wage workers.

Key words: Commuting, Physical activity, Low back pain, Employees, Korean working conditions survey

Introduction

Low back pain (LBP) is a common health problem worldwide[1)]. In 2019, there were 568.4 million cases of LBP; further, LBP remains the leading cause of age-standardised years lived with disability rates globally[2)]. LBP-related disability is especially high in the working-age groups between 40 and 69 yr[3)]. Additionally, chronic LBP increases absenteeism, reduces the chances of returning to work, and raises the possibility of permanent disability[4, 5)]. Accordingly, LBP is a major public health problem in workplaces that causes a high socioeconomic burden by decreasing productivity among workers[6)].

LBP has complex and multifactorial contributors, including physical, psychological, and social aspects[7)]. Occupational factors are directly related to LBP; therefore,

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several studies have investigated work-related LBP. Work-related LBP occurs in occupational environments, including awkward or prolonged standing posture[8, 9], lifting and carrying heavy objects[10], sedentary posture[11], and job stress[12].

Commuting time to work is another risk factor for work-related LBP[13]. Employees with longer commutes reported experiencing more musculoskeletal symptoms[14, 15]. While commuting to work, individuals are stuck in cars or public transportation seats; accordingly, these fixed postures and prolonged seating can induce LBP[16]. On the other hand, engaging in physical activity during leisure time has a protective effect against LBP[17, 18], since it increases the strength and flexibility of the spine, factors that are related to the risk of spine injury[19]. However, there is a trade-off between commuting time and leisure time, as longer commutes often result in relatively limited leisure time[20]. Therefore, leisure-time physical activities should be considered when investigating the impact of commuting time on work-related LBP.

In Korea, LBP accounted for 28.2% and 37.3% of all occupational diseases and work-related diseases, respectively, in 2020. As a single diagnosis, LBP accounts for the largest proportion of work-related diseases[21]. As the average age of workers increases, there is a gradual increase in the number of work-related LBP cases[22, 23]. Additionally, Koreans spend about 58 min a day commuting to and from work, with Korea having the longest commuting time (twice the average of other countries) according to the Organization for Economic Co-operation and Development[24].

Accordingly, the negative effects of commuting time on work-related LBP should not be overlooked; however, few studies have addressed the relationship between commuting time and work-related LBP in Korea. It has been reported that the social cost of commuting alone, directly and indirectly, amounts to KRW 171 trillion per year in Korea[25]. When considering the health-related costs alongside this, it becomes evident that the socioeconomic burden of commuting is tremendous, making it a critical health and societal concern. Therefore, there is a need for this study to evaluate the relationship between work-related LBP and commuting time to reduce individual and social burdens at a national level. This study aimed to investigate the relationship between commuting time and work-related LBP among Korean workers with respect to sports and leisure activities using nationally representative data. We hypothesized that workers with longer commutes would experience a higher incidence of work-related LBP, even after adjusting for sports and leisure activities.

Subjects and Methods

Data and sample

This study used data from the sixth Korean Working Conditions Survey (KWCS) conducted in 2020–2021 by the Occupational Safety and Health Research Institute. The KWCS was designed to elucidate the overall work environment, including work and employment types, occupations, industries, and exposure to risk factors, as well as to benchmark the European Working Conditions Survey (EWCS) and the Labor Force Survey in the UK. The target population for the 6th KWCS includes individuals aged 15 years and above who are employed and residing in households across South Korea at the time of the survey. Employed individuals are defined as those who have engaged in 'income'-generating work for at least one hour within the past week, following the criteria used in the EWCS.

The sample size was determined as 50,000, considering both the survey expenses and the precision derived from preceding survey. By utilizing the census districts outlined in the 2018 Census as the sampling frame, the 5,000 census districts were employed from 17 cities and provinces through probability proportional sampling. From each of these census districts, 10 households were sampled through cluster sampling. Ultimately, one eligible member from each household was randomly selected to participate in the survey. Trained interviewers then conducted one-on-one interviews with the chosen household members using tablet PCs to assist with data collection.

Among the 50,538 respondents of the sixth KWCS, we included wage workers aged >20 yr (n=32,916). We excluded self-employed persons without employees, self-employed persons/business owners with employees, unpaid family workers, and other workers. Further, we excluded individuals who reported a commuting time of 0 minutes or those who worked from home (n=492), individuals with LBP not related to work (n=2,551), and individuals with missing variables of interest (n=1,671). Finally, the data of 28,202 wage workers were analysed. The study population was weighted according to family size based on the 2021 Economically Active Population Survey of Korea (sum of weights=32,859).

Commuting time

The participants responded to the following question: 'How many minutes does the total daily commute usually take'? Responses were collected as continuous variables and categorised for analysis. The self-reported commuting

time was classified as follows: <20, 20–39, 40–59, 60–79, and ≥80 min/d.

Work-related LBP

The presence of work-related LBP was indicated by a 'yes' response to both of the following questions: 'Over the last 12 months, did you have LBP?' and 'If you had LBP, was it related to your work?' Participants who answered that they did not have LBP were included in the control group. Respondents with LBP not related to work were excluded.

Sports and leisure activities

The participants were asked the following question: 'How often do you engage in sports and leisure activities outside of work'? The responses were divided into Yes ('Everyday', 'several times a week', and 'several times a month') and No ('Rarely', and 'Never').

Ergonomic risk factors

The ergonomic risk factors included exposure to an awkward posture, lifting or carrying people, carrying heavy loads, continuously standing, and sedentary posture. The participants answered questions regarding each risk factor based on a seven-point scale (all of the working time, almost all of the working time, 3/4 of the working time, half of the working time, 1/4 of the working time, almost never, and never). Responses were classified as exposure (all of the working time, almost all of the working time, 3/4 of the working time, half of the working time, and 1/4 of the working time) and lack of exposure (almost never, and never).

Covariates

General and occupational characteristics, as well as sports and leisure activities, were used as covariates. The general characteristics included sex, age, and education level. Age was classified as follows: '20−29 yr', '30−39 yr', '40−49 yr', '50−59 yr', and '≥ 60 yr'. Education level was classified as 'High school or lower' and 'College or higher'.

The occupational characteristics comprised monthly income, occupation, employment status, weekly working hours, and job stress, in addition to ergonomic risk factors. Occupations were classified into nine categories based on the Korean Standard Classification of Occupations. Managers, professionals and related workers, and clerks were classified as 'white-collar workers'; service workers and sales workers were classified as 'pink-collar workers'; and skilled workers in agriculture, forestry and fishery workers, craftsmen and related technical workers, equipment/machine operators, assembly workers, and elementary workers were classified as 'blue-collar workers'. Employment status was classified as 'regular workers' and 'temporary/daily workers'. In Korea, working 40 h/week is regarded as standard work; moreover, up to 12 h of overtime per week is permitted by law. Accordingly, weekly working hours were classified as '<40 h', '40−51 h', and '≥52 h'. Monthly income was classified as '<2 million won', '2−2.99 million won', and '≥3 million won'. Job stress was assessed using the following question: 'Do you experience stress in your work'? Responses were classified as Yes ('Always', 'Most of the time', and 'Sometimes') and No ('Rarely', and 'Never').

Statistical analyses

All variables were analysed using the chi-square test to examine differences in general characteristics, occupational characteristics, ergonomic risk factors, and commuting time between workers with and without work-related LBP. Additionally, we performed a frequency analysis of the prevalence of work-related LBP by commuting time after stratifying workers into those with and without sports and leisure activities. Multiple logistic regression analysis was used to calculate the adjusted odds ratios (ORs) and 95% confidence intervals (95% CIs) for work-related LBP. Workers with <20 min of commuting time were used as the reference group. . The crude OR was estimated using unadjusted model. Model 1 was adjusted for sex, age, education level, income, occupation, employment status, working hours, job stress, and ergonomic risk factors. In Model 2, sports and leisure activities was adjusted in addition to Model 1. Finally, workers were stratified by with/without sports and leisure activities and analyzed using the same approach. Statistical significance was set at $p<0.05$. All statistical analyses were performed using R (version 4.2.1; R Core Team, 2022).

Results

Table 1 shows the characteristics of the study population according to work-related LBP. The final weighted data included 18,863 men and 13,995 women. Work-related LBP was found in 19.5% and 21.9% of the men and women, respectively. There were significant between-group differences in the distributions of all general and occupational factors. Workers who were older, had lower education level, and did not engage in sports and leisure activities

Table 1. General and occupational characteristics of the study population according to work-related low back pain

Characteristics	Work-related low back pain		
	No (n=26,129)	Yes (n=6,730)	*p*-value
Sex			0.001
Men	15,192 (80.5%)	3,671 (19.5%)	
Women	10,936 (78.1%)	3,059 (21.9%)	
Age (yr)			<0.001
20–29	5,077 (88.4%)	663 (11.6%)	
30–39	6,280 (83.8%)	1,213 (16.2%)	
40–49	6,384 (78.1%)	1,789 (21.9%)	
50–59	5,349 (74.0%)	1,877 (26.0%)	
≥60	3,039 (71.9%)	1,188 (28.1%)	
Education level			<0.001
High school or lower	9,617 (72.2%)	3,704 (27.8%)	
College or higher	16,512 (84.5%)	3,025 (15.5%)	
Income (10,000 won/month)			0.001
<200	6,928 (77.9%)	1,965 (22.1%)	
200–299	8,597 (79.1%)	2,279 (20.9%)	
≥300	10,604 (81.0%)	2,487 (19.0%)	
Occupation			<0.001
White collar	13,130 (85.2%)	2,272 (14.8%)	
Pink collar	4,633 (81.4%)	1,060 (18.6%)	
Blue collar	8,365 (71.1%)	3,397 (28.9%)	
Employment status			<0.001
Regular	21,285 (80.3%)	5,214 (19.7%)	
Temporary/part-time	4,844 (76.2%)	1,515 (23.8%)	
Working hours/week			<0.001
≤40 h	4,731 (78.2%)	1,320 (21.8%)	
41–52 h	19,852 (80.6%)	4,768 (19.4%)	
≥53 h	1,546 (70.7%)	642 (29.3%)	
Job stress			<0.001
No	6,209 (84.8%)	1,111 (15.2%)	
Yes	19,920 (78.0%)	5,619 (22.0%)	
Sports and leisure activities			<0.001
No	14,423 (76.2%)	4,495 (23.8%)	
Yes	11,706 (84.0%)	2,234 (16.0%)	
Commuting time (min/d)			<0.001
<20	2,418 (82.6%)	508 (17.4%)	
20–39	8,947 (81.1%)	2,079 (18.9%)	
40–59	6,252 (79.5%)	1,614 (20.5%)	
60–79	4,282 (77.4%)	1,250 (22.6%)	
≥80	4,231 (76.8%)	1,278 (23.2%)	

Data are shown as numbers (%), not otherwise specified. All numbers reflect weighted frequencies rounded to the nearest whole number.

showed a higher prevalence of work-related LBP. Regarding occupational characteristics, workers with blue-collar jobs, temporary/part-time jobs, long working hours, low incomes, and high job stress had a higher prevalence of work-related LBP. The proportion of workers with work-related LBP increased according to their commuting time.

We investigated the frequency distribution of the ergonomic risk factors and work-related LBP (Table 2). There were higher proportions of work-related LBP in workers exposed to awkward posture, lifting or carrying people, carrying heavy loads, and continuous standing posture than in unexposed workers. However, workers exposed to

Table 2. Ergonomic risk factors of the study population according to work-related low back pain

Risk factors	Work-related low back pain		
	No (n=26,129)	Yes (n=6,730)	*p*-value
Awkward posture			<0.001
Lack of exposure	18,616 (86.2%)	2,982 (13.8%)	
Exposure	7,513 (66.7%)	3,748 (33.3%)	
Lifting or carrying people			<0.001
Lack of exposure	24,632 (80.8%)	5,845 (19.2%)	
Exposure	1,497 (62.9%)	884 (37.1%)	
Carrying heavy loads			<0.001
Lack of exposure	20,004 (84.7%)	3,609 (15.3%)	
Exposure	6,125 (66.2%)	3,121 (33.8%)	
Standing continuously posture			<0.001
Lack of exposure	10,179 (83.2%)	2,056 (16.8%)	
Exposure	15,950 (77.3%)	4,673 (22.7%)	
Sedentary posture			<0.001
Lack of exposure	6,368 (74.9%)	2,135 (25.1%)	
Exposure	19,761 (81.1%)	4,595 (18.9%)	

Data are shown as numbers (%), not otherwise specified. All numbers reflect weighted frequencies rounded to the nearest whole number.

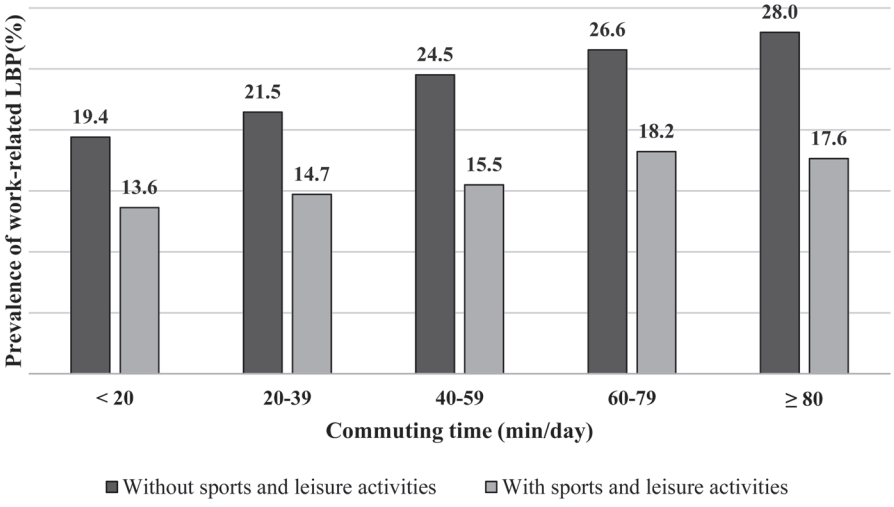

Fig. 1. The prevalence of work-related low back pain by commuting time according to with/without sports and leisure activities.

sedentary posture had a lower proportion of work-related LBP than unexposed workers.

Additionally, we examined the prevalence of work-related LBP with respect to commuting time according to sports and leisure activities (Fig. 1). Workers without sports and leisure activities had more work-related LBP than those with sports and leisure activities. The prevalence of work-related LBP tended to increase as commuting time increased in both groups.

We performed multiple logistic regression analyses to investigate the relationship between commuting time and work-related LBP (Table 3). A commuting time of >40 min was positively associated with work-related LBP in both the crude and adjusted models. Moreover, the ORs increased as the commuting time increased.

Table 4 shows the results of logistic regression analyses of work-related LBP stratified according to sports and leisure activities. In the crude model, among workers

Table 3. The odds ratio and 95% confidential intervals of work-related low back pain according to commuting time

Commuting time (min/d)	Work-related low back pain					
	Crude		Model 1[a]		Model 2[b]	
	OR	95% CI	OR	95% CI	OR	95% CI
<20	1.00	(Reference)	1.00	(Reference)	1.00	(Reference)
20–39	1.11	(0.99, 1.23)	1.07	(0.96, 1.20)	1.08	(0.96, 1.21)
40–59	1.23	(1.10, 1.37)	1.19	(1.06, 1.34)	1.22	(1.08, 1.37)
60–79	1.39	(1.24, 1.56)	1.40	(1.24, 1.58)	1.44	(1.27, 1.63)
≥80	1.44	(1.28, 1.61)	1.80	(1.59, 2.04)	1.83	(1.62, 2.08)

[a]Model 1: The adjusted model was adjusted for sex, age, education level, income, occupation, employment status, working hours, job stress, and ergonomic risk factors (awkward posture, lifting or carrying people, carrying heavy loads, standing continuously, sedentary posture).
[b]Model 2: Model 1 + sports and leisure activities.
OR: odds ratio; CI: confidence interval.

Table 4. The odds ratio and 95% confidential intervals of work-related low back pain according to commuting time stratified by with/without sports and leisure activities

Commuting time (min/d)	Work-related low back pain			
	Crude		Adjusted model[a]	
	OR	95% CI	OR	95% CI
Without sports and leisure activities				
<20	1.00	(Reference)	1.00	(Reference)
20–39	1.14	(1.00, 1.29)	1.10	(0.96, 1.26)
40–59	1.35	(1.18, 1.54)	1.29	(1.12, 1.49)
60–79	1.50	(1.31, 1.73)	1.42	(1.22, 1.65)
≥80	1.62	(1.41, 1.86)	1.96	(1.68, 2.28)
With sports and leisure activities				
<20	1.00	(Reference)	1.00	(Reference)
20–39	1.09	(0.90, 1.33)	1.02	(0.83, 1.26)
40–59	1.16	(0.95, 1.42)	1.06	(0.86, 1.32)
60–79	1.42	(1.15, 1.74)	1.41	(1.13, 1.75)
≥80	1.36	(1.11, 1.67)	1.60	(1.28, 1.99)

[a]The adjusted model was adjusted for sex, age, education level, income, occupation, employment status, working hours, job stress, and ergonomic risk factors (awkward posture, lifting or carrying people, carrying heavy loads, standing continuously, and sedentary posture).
OR: odds ratio; CI: confidence interval.

without sports and leisure activities, a commuting time of ≥40 min showed higher ORs with 1.35 (1.18–1.54), 1.50 (1.31–1.73), and 1.62 (1.41–1.86) for 40–59, 60–79, and ≥80 min, respectively. Meanwhile, higher ORs were found among workers who participated in sports and leisure activities with 60–79 min, and ≥80 min of commuting time [1.41 (1.15–1.74) and 1.36 (1.11–1.67), respectively]. In the adjusted model, the ORs of work-related LBP were 1.29 (1.12–1.49), 1.42 (1.22–1.65), and 1.96 (1.68–2.28) for workers without sports and leisure activities with 40–59, 60–79, and ≥80 min of commuting time, respectively. The ORs were 1.41 (1.13–1.75) and 1.60 (1.28–1.99) for workers engaging in sports and leisure activities with a commuting time of 60–79 and ≥80 min, respectively.

Discussion

We found a negative relationship between commuting time and work-related LBP among Korean workers. Specifically, long commuting time was independently related to the risk of work-related LBP after adjusting for sports and leisure activities as well as other ergonomic risk factors, and the risk became higher as commuting time increased. Moreover, our findings were especially apparent

for workers without sports and leisure activities.

There were significant between-group differences in the distribution of general and occupational characteristics. Consistent with previous findings, the prevalence of work-related LBP increased with age and was higher in women, blue-collar workers, individuals with low socioeconomic status, and workers with high job stress[26, 27]. Work-related LBP is caused by biomechanical mechanisms such as excessive loading and repetitive stress on spinal structures[28]. Therefore, age-related degenerative changes in the spine, maternal and household duties among women, and physical labor in blue-collar occupations contribute to vulnerability to work-related LBP[29, 30]. Additionally, low healthcare accessibility in low socioeconomic groups and the exacerbation of self-reported symptoms due to high job stress are also factors associated with work-related LBP[7].

All ergonomic risk factors were significantly associated with work-related LBP. Exposure to ergonomic risk factors has been shown to increase the incidence of work-related LBP; however, we observed a negative association between sedentary working and work-related LBP. Although extended sitting time is a known risk factor for LBP[11], the association between sitting while at work and LBP remains unclear[31]. Increased sedentary work may contribute to reduced physical labour and decreased exposure to other ergonomic risk factors during working hours.

After adjusting for other confounding factors, we found a positive correlation between commuting time and work-related LBP. This implies that commuting time is an independent risk factor for work-related LBP. After stratification according to sports and leisure activities, the impact of commuting time on work-related LBP among workers who participated in sports and leisure activities generally diminished. This is consistent with previous findings that sports and leisure time have a protective effect against LBP[17]. This supports the argument that physical inactivity can lead to a deterioration in the structure and function of the lower back, rendering it more susceptible to the development of low back pain and increasing the risk of acute low back pain progressing to a chronic condition[19, 32].

The relationship between commuting time and work-related LBP could involve several possible mechanisms. First, longer commuting time is associated with less time spent on physical activity[33]. Further, there is a trade-off between commuting time and health-related activities[20]. Therefore, increased commuting time forces workers to spend less time participating in sports and leisure. Second, exposure to vibrations and static posture while commuting can directly cause work-related LBP. Exposure to vibrations from automobiles or public transportation, as well as prolonged sitting or standing in a vehicle, increases the risk of acute stress to the herniated lumbar intervertebral disk, which is associated with work-related low back pain[34, 35]. Additionally, the uncomfortable commuting environment before and after work worsens fatigue and hinders recovery from work[36]. Traffic congestion is a source of stress[15, 37]; further, commuting can provoke stress-related health problems, including physical ailments[38, 39]. Since longer commuting is more burdensome for workers[40], it is important to consider commuting-induced psychological stress when addressing work-related LBP. Because of these mechanisms, our findings could indicate a dose-response relationship between commuting time and work-related LBP.

Work-related LBP is the most common cause of medically certified sick leave[7, 41]. In addition, work-related LBP contributes to accidents among workers and increases the prevalence of headaches, systemic fatigue, and mental illness[42]. Also, according to the Occupational Safety and Health Research Institute[43], the number of wage workers with self-reported LBP increased in the sixth survey when compared to the previous survey conducted in 2017. Therefore, awareness and interventions for work-related LBP are becoming more important for reducing lost workdays and industrial accidents.

The following suggestions at the company level should be considered to reduce work-related LBP among workers. First, customised commuter buses could be promoted to decrease transit time and improve commuting quality since they are more efficient for commuters than cars or conventional public transport services[44]. Second, flexible work arrangements could be initiated to avoid rush hour and reduce the stress of commuting congestion[45]. Finally, exercise time should be allocated during work to encourage workers to engage in sports and leisure activities[46].

Limitations and strength

This study has several limitations. First, since this was a cross-sectional study, we could not elucidate the causal relationship between commuting time and work-related LBP. Further longitudinal studies are warranted to overcome this limitation. Second, owing to limited data, we could not adjust for several confounding factors for LBP, including smoking, obesity, and underlying medical history. Third, we could not estimate the effects of commuting modes. The finding that active commuting (walking or cycling) improves LBP may underestimate our results. However, since the proportion of active commuters in Ko-

rea is only 16.0% (56.6% for private cars and 26.2% for public transportation)[47], this may not have decisively affected our findings. Furthermore, it''s worth noting that using public transportation often involves active commuting, which could potentially lead to differences in low back pain between private car and public transportation commuters. However, there is currently a lack of research on the disparities between private car and public transportation in this regard. Fourth, since we assessed self-reported work-related LBP, the results might be imprecise and vulnerable to recall bias. Finally, the assessment of sports and leisure activities was conducted through a survey, which is not a validated measurement. Since the primary focus of this study was on commuting time, it is expected to have had minimal impact on the conclusions. As similar question was utilized in the 1970 British Cohort Study[48], and the validity and reliability of the second KWCS, which included the same question, were confirmed[49], we believed that this question was sufficient to distinguish whether or not employees engaged in sports and leisure activities. We were also unable to incorporate the duration of leisure-time physical activity practice due to either incomplete investigation or lack of data. However, there is evidence suggesting that a dose-response relationship between LBP and physical activity has not been established[50], indicating that it would not have had a significant impact.

A major strength of this study is the inclusion of various socioeconomic, occupational, and ergonomic factors as confounding factors. Additionally, we were able to enhance the robustness of the study by controlling the effects of sports and leisure activities through stratification. Finally, this was the first study to examine the association between commuting time and work-related LBP in the whole country using large, nationally representative data with guaranteed validity and reliability in Korea[49].

In future research, adding variables such as commuting modes and using validated surveys related to leisure-time physical activity could be considered. Furthermore, if studies on the relationship between long commutes and various diseases, including mental health and musculoskeletal conditions, as well as cardiovascular diseases, are conducted, commuting time may be viewed not only as a social issue but also as a significant public health concern that requires a policy-oriented approach.

Conclusion

This study demonstrates that commuting time is positively correlated with the risk of work-related LBP among Korean wage workers and it highlights that engagement in sports and leisure activities can mitigate this adverse effect. Based on this, at the individual level, it can raise awareness among employees about the significant health risks associated with long commutes and encourage them to consider the distance to their workplace as an important factor in choosing their place of residence. At the company level, there is a need to formulate policies aimed at reducing commuting time, such as implementing commuter buses or flexible work arrangements, and providing sports and leisure activities, all with consideration for the health of employees. Furthermore, we expect the transportation policy to be decided more carefully at the government level because a well planned transportation system can improve commuting time.

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