

## ORIGINAL ARTICLE

# The relationship between working hours and lifestyle behaviors: Evidence from a population-based panel study in Korea

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**Abstract**

**Objectives:** This study aimed to investigate the relationship between working hours and lifestyle behaviors using data from a large nationally representative panel survey.

**Methods:** We used the Korea Health Panel Study (KHPS) data from 2011 to 2014. Weekly working hours and lifestyle risk factors were assessed by questionnaires. Comparing to the reference group, the weekly working hours were 40 h per week, odds ratios and 95% confidence intervals for smoking status, alcohol consumption status, and regular exercise status of other weekly working hours groups (<40, 40, 41–52, and >52) were calculated, using generalized estimating equation models considering repeated measures.

**Results:** Our findings clearly showed a relationship between long working hours and unhealthy lifestyles, such as cigarette smoking, alcohol consumption, physical inactivity, and insufficient sleep. Additionally, weekly working hours are positively associated with the amount of smoking and drinking, and inversely associated with sleep duration among those who worked 40 h or more per week.

**Conclusion:** Long working hours are associated with unhealthy lifestyles, such as cigarette smoking, alcohol consumption, physical inactivity, and insufficient sleep.

**KEYWORDS**

alcohol drinking, exercise, life style, long working hours, sleep, smoking

## 1 | INTRODUCTION

Since the 1970s, there has been a growing interest in the health effects of long working hours. Many studies have found that long working hours are associated with general health complaints, fatigue, diabetes, hypertension, cardiovascular disease, a shortage of sleep, stress, depression,

musculoskeletal disorders, occupational injuries, and all-cause mortality.<sup>1–4</sup> The mechanisms underlying these relationships include incomplete physical recovery, insufficient stress relief, and unhealthy lifestyle.<sup>2</sup>

Lifestyle factors such as smoking, consumption of alcohol, physical inactivity, and insufficient sleep, are also risk factors in a range of serious diseases, including

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hypertension, type II diabetes, cardiovascular disease, stroke, cancer, mental disorders, and all-cause mortality.<sup>5</sup> These health-related behaviors are known to be associated with a variety of individual and socioeconomic factors, including personality, gender, ethnicity, socioeconomic status, and education, workplace environment.<sup>6</sup> However, the mediating role of health behaviors in the relationship between long working hours and morbidity is still unclear, and more comprehensive evidence is required to clarify these mechanisms.

Although there is relatively little evidence assessing associations between long working hours and lifestyle behaviors, some studies have suggested a relationship between these factors, with inconsistent results. For example, while a positive association has been reported between long working hours and lack of physical activity during leisure time,<sup>7,8</sup> other studies have observed no negative associations.<sup>9</sup> These inconsistent results may be related to several methodological shortcomings, including small sample sizes, cross-sectional study design, workers in one company, or particular industry-specific circumstances that limit generalizability of the findings.<sup>10–14</sup> Therefore, to better identify the mechanisms and mediators of the relationships between long working hours and various diseases, longitudinal research is needed using wider populations with different occupations.

Consequently, to overcome the weaknesses of previous literature, the present study investigates the relationship between working hours and lifestyle behaviors using data from a large nationally representative panel survey. This allows analysis of intrapersonal changes in working hours and in health behavior and its sustained intensity, thus reducing the extent to which the results are biased due to omitted variables. With this approach, all time-invariant influences on the resulting variable remain constant, thereby greatly reducing the likelihood of the omitted variable bias. The nationally representative nature of the data also means that we can generalize to wider populations with different occupations. Given that the results would be significantly modified by occupation type, our study further explores the relationship between working hours and lifestyle behaviors by considering the type of occupation.

## 2 | MATERIALS AND METHODS

### 2.1 | Study population

We used the Korea Health Panel Study (KHPS) data from 2011 to 2014. The KHPS has been conducted by the Korea

Institute for Health and Social Affairs (KIHASA) and the National Health Insurance Service (NHIS) of South Korea, to provide data on individual, social, and environmental elements on healthcare expenditure. Study participants were recruited using a two-stage stratified sampling method from the population census data. KHPS was first conducted in 2008 and has been conducted annually. In KHPS, a trained interviewer visits the study participant's home and conducts a computer-assisted personal interview. We included the study participants who were paid employees and aged between 20 and 59 years, given the legal retirement age of South Korea. The KHPS is a panel study that repeatedly measured the participants but included or excluded them in each panel follow-up according to their employee status and recruited new participants in 2014. Individuals who were working, paid employees were included, and those who with missing information on the variables were excluded. Therefore, among a total of 25 023 individuals who participated in the KHPS from 2011 to 2014, 6937 participants were selected for the current study.

### 2.2 | Working hours and job characteristics

The weekly working hours of participants were determined using the following question: “How many hours do you work a week, including overtime?” The Labor Standards Act in South Korea stipulates that work hours shall not exceed 40 h a week, excluding hours of recess. The Act also stipulates that, if an agreement is made between the parties, work hours can be extended by up to 12 h per week. Given this background, Korean workers without overtime work tend to report their working hours as 40 h.<sup>15</sup> Therefore, we classified the weekly working hours of participants into four groups as following: <40 (short weekly working hours), 40 (standard, and the most frequent weekly working hours), 41–52 h (usually permitted overtime work), and >52 h (overtime work allowed in extraordinary situations). Job class was determined using the Korean Standard Classification of Occupation, and we classified managers, professionals, technicians, and associated professionals into white collar. Clerical support workers, service and sales workers, skilled agricultural, forestry and fishery workers, craft and related trades workers, plant and machine operators and assemblers, and elementary occupations were classified as blue collar. Shiftwork was assessed using the following question: “Do you usually work between 06:00 and 18:00, or do you follow a different schedule?”.

## 2.3 | Lifestyle risk factors

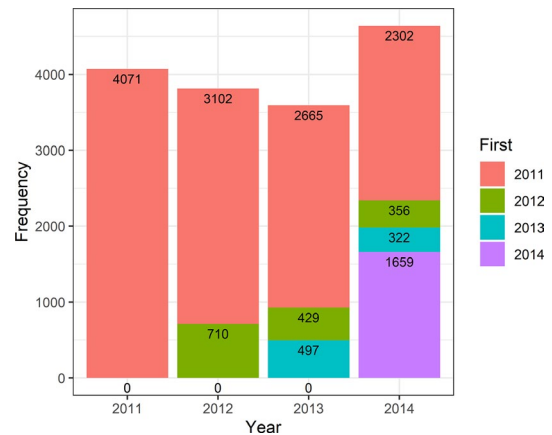
Current smoking status was assessed using the following question: “Do you currently smoke?” Participants who responded yes were additionally asked about the number of cigarettes smoked a day as follows: “How many cigarettes do you smoke a day?” The frequency of alcohol consumption in the last year was assessed. Those who reported that they did not drink in their lifetime or in the last year were classified as “non-drinker.” Those who consumed alcohol were asked about the number of standard glasses on a drinking day. We calculated the consumed alcohol in grams per month using these questionnaires. Risky alcohol consumption was defined according to the definition of the National Institute on Alcohol and Alcoholism of the United States<sup>16</sup> as either (1) exceeding the recommended levels for weekly alcohol consumption (>14 standard drinks for men or >7 standard drinks for women) or (2) exceeding recommended daily drinking limits (>4 drinks once a month or more often). We asked about the frequency and duration of vigorous and moderate-intensity physical activity. Adequate physical activity was defined as performing moderate physical activity  $\geq 30$  min at a time, three or more times a week, and/or vigorous physical activity  $\geq 20$  min at a time, three or more times a week. Sleep duration was determined as follows: “How many hours a day have you slept over the past week, on average?” Finally, we assessed six lifestyle risk factors as follows: smoking status (yes vs. no, dichotomous variable), smoking cigarettes per day if participants currently smoke (continuous variables), consume alcohol (yes vs. no, dichotomous variable), and grams of alcohol consumed per month if participants currently drink.

## 2.4 | Other variables

We used data on gender, age, education level, and household income of the study participants. Age was grouped into 20–29, 30–39, 40–49, and 50–59. Education level was classified into high school or below, and college or above. Household income, including labor income and financial income, was calculated on an equalized scale by dividing the income by the square root of the number of household members,<sup>17</sup> and it was grouped into tertiles.

## 2.5 | Statistical analyses

The data of the study participants were measured repeatedly from one to four times annually during the



**FIGURE 1** Follow-up status of the study participants between the study period (2011–2014)

study period (Figure 1). First, given the repeated data, a generalized mixed-effects model was constructed to assess the association between weekly working hours and lifestyle risk factors. We used the GAMM package of R version 3.4.4 (R Foundation for Statistical Computing). Smoking status, alcohol consumption status, and regular exercise status were dichotomous variables, so we used binomial family in addition to random intercept for individuals and autoregressive correlation structure. Cigarettes smoked per day, alcohol consumption per month, and daily sleeping time were continuous variables, so we used quasi-Poisson family as their variance was greater than the mean, in addition to random intercept for individuals and autoregressive correlation structure. Next, we constructed generalized estimating equation (GEE) models considering repeated measures. We used the PROC GENMOD protocol of SAS version 9.4 (SAS Institute). Comparing to the reference group, the weekly working hours were 40 h per week, odds ratios (ORs) and 95% confidence intervals (CIs) for smoking status, alcohol consumption status, and regular exercise status of other weekly working hours groups (<40, 40, 41–52, and >52) were calculated. Furthermore, comparing to the reference group, beta estimates ( $\beta$ ) and standard error (SE) for cigarettes smoked per day, alcohol consumption per month, and daily sleeping time of other weekly working hours groups (<40, 40–52, and >52) were estimated using the negative binomial model, and percent changes and 95% CIs were calculated as  $(e^{\beta}-1)\times 100$  and  $(e^{\beta(\pm SE)}-1)\times 100$ . We constructed GEE models for all participants and constructed stratified models for males and females separately. Additionally, GEE models were constructed after stratification for household income, occupational group, and shiftwork. Two-tailed *P*-values <.05 were considered statistically significant.

## 2.6 | Ethics statement

This study was carried out in accordance with the guidelines set out in the Declaration of Helsinki and exempted from deliberation by the Institutional Review Board of Seoul St. Mary's Hospital, the Catholic University of Korea (IRB number: KC21ZASI0645).

## 3 | RESULTS

The characteristics of the study participants are reported in Table 1. The number of study participants was 4071, 3812, 3591, and 4639 in 2011, 2012, 2013, and 2014, respectively. Among the participants, there were more men than women. Most people were 40–49 years, college educated, blue-collar workers, and non-shift workers. The follow-up status of the participants during the study period is

illustrated in Figure 1. A total of 2302, 356, 322, and 2188 participants participated in surveys four, three, two, and one times, respectively. Lifestyle risk factors of the study participants are summarized in Table 2.

The nonlinear association between weekly working hours and lifestyle risk factors is presented in Figure 2. Smoking status was positively and significantly associated with working hours of 30 h or longer per week. Among smokers, working hours and the number of cigarettes smoked per day were linearly associated. Risky alcohol drinking and the amount of alcohol consumption were also significant and positively associated with weekly working hours of 30 h or longer per week. There was no significant association between whether people exercised regularly and weekly working hours. Sleep duration hours were negatively associated with weekly working hours, and this association was only significant among people who worked 40 h a week or longer.

	2011	2012	2013	2014
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Total	4071 (100.0)	3812 (100.0)	3591 (100.0)	4639 (100.0)
Gender				
Male	2426 (59.6)	2234 (58.6)	2096 (58.4)	2698 (58.2)
Female	1645 (40.4)	1578 (41.4)	1495 (41.6)	1941 (41.8)
Age				
20–29	560 (13.8)	528 (13.9)	489 (13.6)	593 (12.8)
30–39	1178 (28.9)	1040 (27.3)	962 (26.8)	1207 (26.0)
40–49	1427 (35.1)	1374 (36.0)	1285 (35.8)	1644 (35.4)
50–59	906 (22.3)	870 (22.8)	855 (23.8)	1195 (25.8)
Education				
≤ High school	1984 (48.7)	1814 (47.6)	1665 (46.4)	2099 (45.2)
≥ College	2087 (51.3)	1998 (52.4)	1926 (53.6)	2540 (54.8)
Household income				
1T	1356 (33.3)	1262 (33.1)	1196 (33.3)	1546 (33.3)
2T	1358 (33.4)	1280 (33.6)	1197 (33.3)	1548 (33.4)
3T	1357 (33.3)	1270 (33.3)	1198 (33.4)	1545 (33.3)
Job classification				
White collar	1798 (44.2)	1696 (44.5)	1628 (45.3)	2150 (46.4)
Blue collar	2273 (55.8)	2116 (55.5)	1963 (54.7)	2489 (53.7)
Shiftwork				
No	3656 (89.8)	3427 (89.9)	3236 (90.1)	4173 (90.0)
Yes	415 (10.2)	385 (10.1)	355 (9.9)	466 (10.1)
Weekly working hours				
<40	358 (8.8)	335 (8.8)	293 (8.2)	390 (8.4)
40	1173 (28.8)	1273 (33.4)	1254 (34.9)	1725 (37.2)
41–52	1410 (34.6)	1239 (32.5)	1209 (33.7)	1549 (33.4)
>52	1130 (27.8)	965 (25.3)	835 (23.3)	975 (21.0)

**TABLE 1** Characteristics of the included study participants

**TABLE 2** Lifestyle risk factors of the study participants

	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
	<b><i>n</i> (%) or mean (<math>\pm</math>SD)</b>	<b><i>n</i> (%) or mean (<math>\pm</math>SD)</b>	<b><i>n</i> (%) or mean (<math>\pm</math>SD)</b>	<b><i>n</i> (%) or mean (<math>\pm</math>SD)</b>
Total	4071 (100.0)	3812 (100.0)	3591 (100.0)	4639 (100.0)
Smoking cigarettes				
No	2757 (67.7)	2643 (69.3)	2486 (69.2)	3184 (68.6)
Yes	1314 (32.3)	1169 (30.7)	1105 (30.8)	1455 (31.4)
Smoking cigarettes per day	15.0 ( $\pm$ 7.7)	14.7 ( $\pm$ 7.6)	14.4 ( $\pm$ 7.3)	14.4 ( $\pm$ 7.5)
Alcohol consumption				
No	621 (15.3)	640 (16.8)	598 (16.7)	895 (19.3)
Yes	3450 (84.8)	3172 (83.2)	2993 (83.4)	3744 (80.7)
Alcohol drinking per week (g)	36.7 ( $\pm$ 51.9)	34.9 ( $\pm$ 49.4)	32.8 ( $\pm$ 45.0)	36.7 ( $\pm$ 49.5)
Risky alcohol drinking				
No	2239 (55.0)	2166 (56.8)	2016 (56.1)	2608 (56.2)
Yes	1832 (45.0)	1646 (43.2)	1575 (43.9)	2031 (43.8)
Regular exercise				
No	2864 (70.4)	2600 (68.2)	2452 (68.3)	3265 (70.4)
Yes	1207 (29.6)	1212 (31.8)	1139 (31.7)	1374 (29.6)
Sleep				
Daily sleeping time (h)	6.9 ( $\pm$ 1.0)	6.9 ( $\pm$ 1.0)	6.9 ( $\pm$ 1.1)	—
Missing	353 (8.7)	312 (8.2)	296 (8.2)	4639 (100)

Abbreviation: SD, standard deviation.

Table 3 shows the association between weekly working hours and lifestyle risk factors of dichotomous variables, including smoking cigarettes, risky alcohol drinking, and regular exercise. Comparing to the reference working hour group, OR for smoking status was significantly higher in 41–52 h/week group (OR: 1.13; 95% CI: 1.07, 1.19) and >52 h/week group (OR: 1.21; 95% CI: 1.14, 1.29). Risky alcohol consumption was significantly associated with long working hours, as compared to 40 h/week group, >52 h/week group showed 1.12 times higher OR (95% CI: 1.02, 1.23) for risk alcohol consumption. ORs for regular exercise of 41–52 and >52 weekly working hours groups were 0.90 (95% CI: 0.83, 0.99) and 0.80 (95% CI: 0.72, 0.88), respectively.

Table 4 shows the association of working hours with continuous lifestyle risk factor variables including smoking cigarettes per day among smoking participants, alcohol consumption per week (g) among people who drink alcohol, and daily sleeping time. People who worked >52 h a week smoked 6.67% (95% CI: 2.92%, 10.57%) more cigarettes than those who worked 40 h a week. This association was significant among males, but not among females. Among participants who consume alcohol, those working >52 h per week had 9.10% (95% CI: 2.78%, 15.81%) more alcohol consumption per month compared with those who worked 40 h per

week. These associations were significant among males, but not among females. Long working hours were significantly associated with decreased daily sleep time. People working >52 h a week showed  $-2.77\%$  (95% CI:  $-3.57\%$ ,  $-1.96\%$ ) shorter sleep duration than those working 40 h a week.

The association between weekly working hours and lifestyle risk factors after stratifying for household income, occupational group, and shift work is illustrated in Figure S1–S6. The associations between weekly working hours and smoking status were more clearly observed among blue-collar workers than white-collar workers, and among workers with shiftwork than without (Figure S1). The associations of weekly working hours with smoking were statistically significant among the lowest tertile of household income group, but not among the middle and highest tertiles. Among blue-collar workers, the association between weekly working hours and the number of cigarettes smoked per day was statistically significant, but this association was not found among white-collar workers (Figure S2). The association between weekly working hours and alcohol consumption status was statistically significant among blue-collar workers and those without shiftwork (Figure S3). However, significant associations between weekly working hours and the amount of alcohol consumption were found among white- and

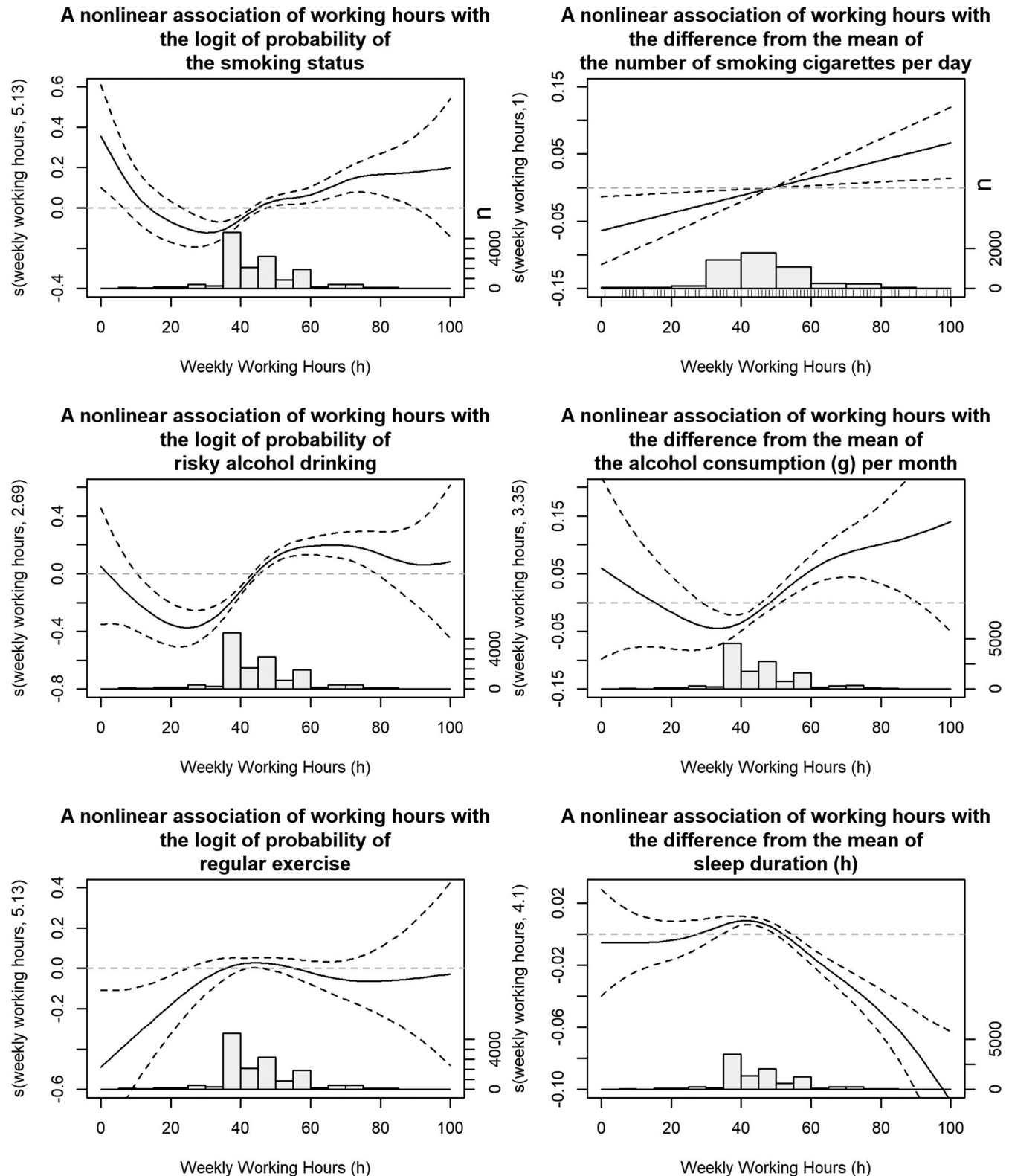


FIGURE 2 The nonparametric association between weekly working hours and lifestyle risk factors using the generalized additive mixed model

blue-collar workers (Figure S4). Long working hours were significantly associated with regular exercise among blue-collar workers and those without shiftwork, but not among white-collar workers and those with shiftwork

(Figure S5). Daily hours of sleep were significantly associated with weekly working hours, and the size of association was larger among shift workers than non-shift workers (Figure S6).

**TABLE 3** The results of the generalized equational model for the associations between weekly working hours and lifestyle risk factors (dichotomous variables)

Weekly working hours	Smoking cigarettes	Risky alcohol drinking	Regular exercise
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Total			
<40	0.96 (0.88, 1.04)	0.95 (0.83, 1.09)	0.92 (0.80, 1.07)
40	1 (Reference)	1 (Reference)	1 (Reference)
41–52	1.13 (1.07, 1.19)**	1.12 (1.03, 1.21)*	0.90 (0.83, 0.99)*
>52	1.21 (1.14, 1.29)**	1.12 (1.02, 1.23)*	0.80 (0.72, 0.88)**
Male			
<40	1.16 (1.01, 1.34)*	0.95 (0.79, 1.13)	0.83 (0.67, 1.04)
40	1 (Reference)	1 (Reference)	1 (Reference)
41–52	1.10 (1.02, 1.19)*	1.09 (0.996, 1.20)	0.93 (0.83, 1.04)
>52	1.10 (1.01, 1.19)*	1.08 (0.98, 1.20)	0.77 (0.68, 0.87)**
Female			
<40	1.71 (1.20, 2.46)*	1.00 (0.80, 1.23)	1.00 (0.82, 1.22)
40	1 (Reference)	1 (Reference)	1 (Reference)
41–52	1.09 (0.79, 1.51)	1.17 (1.02, 1.36)*	0.84 (0.73, 0.97)*
>52	1.65 (1.18, 2.31)*	1.31 (1.09, 1.59)*	0.89 (0.74, 1.07)

Adjusted for age as a continuous variable, education, household income group, occupation group, and shiftwork.

Abbreviations: CI, confidence interval; OR, odds ratio.

\* $P < .05$ ; \*\* $P < .001$ .

## 4 | DISCUSSION

The findings clearly provide supporting evidence of a relationship between long working hours and unhealthy lifestyles, such as cigarette smoking, alcohol consumption, physical inactivity, and insufficient sleep. Additionally, our results revealed that weekly working hours are positively associated with the amount of smoking and drinking, and inversely associated with sleep duration among those who worked 40 h or more per week. Overall, the associations were not linear and differed among workers with different types of occupation. The associations with smoking status, the number of cigarettes smoked per day, risky alcohol consumption, and regular exercise were more prominent among blue-collar than white-collar workers, although the amount of alcohol consumption was more strongly associated with weekly working hours among white-collar than blue-collar workers. Lifestyle risk factors were statistically significantly associated with long working hours among people who do shiftwork, but not among people who do not, except for the daily amount of sleep. These results may explain the inconsistent findings in previous studies.

To date, several studies have attempted to identify associations between working hours and smoking. Van der Hulst conducted a systematic review of regarding research

and identified seven studies.<sup>3</sup> We identified many other studies on the relationship between long working hours and smoking.<sup>19–24</sup> Some found no clear relationship between long working hours and smoking behavior,<sup>22,24</sup> but others have reported a higher risk of smoking in people who work 40 or more hours per week than those who work 30 to 40 h per week,<sup>25</sup> and those long working hours are correlated with a lower probability of quitting smoking.<sup>20</sup> Although there was a study based on longitudinal data and within-person analysis,<sup>18</sup> most of these studies were based on interpersonal analysis and intraindividual variation was not properly considered. Our analysis of panel data suggests that the number of cigarettes smoked may increase even within the same person if they work for a long time.

Similarly, the results of our analysis suggests that long working hour is associated with risky alcohol drinking and the amount of alcohol consumption, which is consistent with previous studies. Virtanen (2015) previously conducted a systematic review and meta-analysis of the impact of exposure to long working hours on the risky alcohol consumption.<sup>4</sup> Based on two published and 18 unpublished prospective studies, this systematic review found that long working hours were associated with a 12% increased risk of new-onset risky alcohol use (OR: 1.12; 95% CI: 1.04–1.20). In addition, compared with

**TABLE 4** The results of the generalized equational model for the associations between weekly working hours and lifestyle risk factors (continuous variables)

Weekly working hours	Smoking cigarettes per day	Alcohol consumption per week	Daily sleeping time
	% change (95% CI)	% change (95% CI)	% change (95% CI)
Total			
<40	4.53 (−0.86, 10.20)	4.79 (−4.95, 15.55)	−1.15 (−2.38, 0.09)
40	(Reference)	(Reference)	(Reference)
41–52	2.32 (−1.00, 5.75)	3.22 (−2.01, 8.83)	−0.58 (−1.26, 0.12)
>52	6.67 (2.92, 10.57)**	9.10 (2.78, 15.81)**	−2.77 (−3.57, −1.96)**
Male			
<40	7.29 (1.82, 13.08)**	11.02 (−1.81, 25.53)	−1.75 (−3.85, 0.39)
40	(Reference)	(Reference)	(Reference)
41–52	2.11 (−1.2, 5.54)	3.08 (−2.60, 9.08)	−0.50 (−1.44, 0.46)
>52	6.42 (2.66, 10.32)**	7.85 (1.07, 15.11)**	−2.96 (−3.99, −1.92)**
Female			
<40	−14.9 (−32.82, 7.79)	3.55 (−11.69, 21.41)	−0.68 (−2.19, 0.84)
40	(Reference)	(Reference)	(Reference)
41–52	−12.42 (−28.61, 7.44)	2.65 (−8.08, 14.64)	−0.72 (−1.72, 0.30)
>52	0.88 (−16.46, 21.82)	13.52 (−0.66, 29.72)	−2.27 (−3.59, −0.94)**

Adjusted for age as a continuous variable, education, household income group, occupation group, and shiftwork.

Abbreviations: CI, confidence interval; OR, odds ratio.

\* $P < .05$ ; \*\* $P < .001$ .

working 35–40 h a week, working 49–54 and  $\geq 55$  h a week was associated with an increase of 17.69 and 16.29 g/week, respectively. More recently, the World Health Organization (WHO) and the International Labour Organization (ILO) have developed Joint Estimates of the work-related burden of disease and injury (WHO/ILO Joint Estimates), with contributions from a large network of experts.<sup>26</sup> Evidence from mechanistic data suggests that exposure to long working hours may increase alcohol consumption and cause alcohol use disorders. However, the experts were uncertain about the effect of long working hours on risky drinking because they found no eligible studies for the evaluation. Hence, they concluded that producing estimates for the burden of alcohol use disorder attributable to exposure to long working hours appears to not be evidence-based. To reach a clear conclusion, further well-designed studies are required to explore the effect of long working hours

on alcohol consumption and alcohol use disorder in various populations.

On the contrary to smoking and alcohol drinking, relatively few studies have examined the association between long working hours and physical inactivity. Fransson et al. investigated a large cohort with 170 162 participants and reported that psychological job distress, such as low job control or inadequate job demands, is associated with leisure-time physical inactivity.<sup>27</sup> However, whether long working hours are associated with physical inactivity is yet to be fully investigated. Evidence on this topic is also mixed, with some research indicating that longer working hours do, in fact, reduce the incidence of regular physical activity,<sup>7,8,28</sup> in accordance with the findings of our study. Other research shows no negative associations.<sup>9</sup> Even among studies that observed significant results, relationships were small in magnitude and/or only significant for certain subgroups.<sup>28</sup> One of the important difference with



our study and some previous ones is the use of repetitive measured data, which allow us to control for unobserved time-invariant covariates.

However, there is general agreement that long working hours adversely affect sleep.<sup>29</sup> A large portion of the literature has reported that long working hours are linked with lower quantity and quality of sleep.<sup>11,12,30–32</sup> Hence, it is believed that insufficient recovery due to sleep deprivation is considered a critical component of the pathway from long working hours to health problems.<sup>12,33</sup> Another experimental study revealed that long working hours reduced sleep time and increased fatigue.<sup>11</sup> Our study provides additional support with respect to evidence for long working hours as a significant predictor of sleep problems.

There are two plausible mechanisms by which working hours can lead to an unhealthy lifestyle. First, long hours of work may act as a stressor because workers tend to feel unsatisfied, less relaxed, and more anxious or stressed when at work than when taking part in most other activities.<sup>19,34</sup> Moreover, long working hours are likely to coincide with high job demands, so it may be an indicator of job strain. A stronger desire to smoke or drink to alleviate job stress may account for the increased cigarette and alcohol consumption associated with long working hours.<sup>35</sup> Second, workers with long working hours have less time to engage in healthy lifestyle habits, such as physical exercise and sufficient sleep.<sup>30</sup> Time constraints may leave some workers with few choices but to rely only on alcohol and smoking as coping strategies to relieve stress. Researchers have reported that a reduction in working time promotes regular exercise, decreases the likelihood of smoking,<sup>36</sup> and leads to beneficial effects on sleep quality and duration.<sup>32</sup> Our findings support this hypothesis.

The stratified analyses identified five findings. First, the magnitude of the association between smoking and risky alcohol drinking is greater for women than for men. It may be that working women are more sensitive to time constraints imposed by long working hours because of the need to balance paid and unpaid work within a rigid household division of labor. This may lead to increased psychological stress, an inability to deal with stress in healthy ways such as exercise, and eventually more dependent on alcohol and smoking. Second, relationships with cigarette smoking and alcohol drinking were more evident in blue-collar men, although how much they drink was significantly associated with working hours, even among white-collar drinkers (Figure S1–S4). Possible explanations for this finding may be cultural differences in enterprises between manual and non-manual jobs.<sup>37</sup> Third, in terms of regular exercise, a more significant association was observed among blue-collar workers, regardless of gender (Figure S5). Such workers may be physically exhausted after working for a long time, so there

is a possibility that they would not be able to engage in further physical activity. In contrast, white-collar workers could have some energy to resolve mental exhaustion through physical exercise even after working for a long time. Fourth, only non-shift workers showed a significant relationship between working hours and the amount of alcohol consumption (Figure S4). Night shift workers would have few opportunities for drinking because their work often finishes in the morning. Fifth, in shift workers, the relationship between long working hours and sleep was especially prominent (Figure S6). This is believed to be because not only the length of working hours but also the timing of the work influences sleep simultaneously. Further research is warranted to gain a clearer understanding of these findings.

The main strength of the present study is the use of nationally representative panel data, which allows the generalization of results to the wider populations of South Korea. Panel data also permit us to explore the probability of within-person changes in lifestyles and working hours, controlling for unobserved time-invariant covariates. Failure to control the time-invariant individual characteristics would bias the results if there were correlations between the observed covariates and unobserved individual fixed effects. This is an important difference with the majority of previous studies based on cross-sectional data in this area. Another notable strength is that not only was the relationship between long work hours and prevalence of unhealthy behaviors considered, but also continuous quantity of smoking, alcohol consumption, and sleep to explore the lifestyles in depth. Additionally, a rigorous statistical analysis of the data was undertaken, revealing a non-linear relationship between working hours and indicators of unhealthy lifestyles.

However, when interpreting our results, some limitations need to be considered. First, our measures are self-reported and brief, so they may be subject to measurement errors. If the collection of biomarkers (e.g., urinary cotinine level) is available in future research, the results may be more reliable. Second, because we used existing data that lacked information on time-varying living and working conditions, job stress, work time control, work–family conflicts, mental disorders, and other factors, we could not control for these in our analysis. Third, our findings cannot necessarily be generalized to other populations with different institutional frameworks and cultural contexts. This is an area for further research. Fourth, the effect of selection should also be considered, because workers with serious drinking or sleep problems may not be able to maintain jobs with long working hours.

In conclusion, the results of this study highlight the importance of working hours as a social determinant of health. Work is important for economic independence and

a meaningful way of life. However, as demonstrated, long working hours are associated with unhealthy lifestyles, such as cigarette smoking, alcohol consumption, physical inactivity, and insufficient sleep. This finding could provide a behavioral mechanism that might explain how poor lifestyle intermediate between long working hours and various health outcomes. Workplace health promotion that ignores working hours may be ineffective in improving workers' lifestyles and preventing future health problems. Consequently, more extensive regulation of working time may be effective for improving public health by reducing unhealthy lifestyles.

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## DISCLOSURES

*Approval of the research protocol:* This study was exempted from deliberation by the Institutional Review Board of Seoul St. Mary's Hospital, the Catholic University of Korea (IRB number: KC21ZASI0645). *Informed Consent:* All participants signed a consent form, and anonymity and confidentiality were assured. *Registry and the Registration No. of the study/trial:* N/A. *Animal Studies:* N/A. *Conflict of Interest:* N/A.

## CONFLICT OF INTERESTS

Authors declare no conflicts of interest.

## AUTHOR CONTRIBUTION

D.W.L. conceived of and designed the study. D.W.L. conducted statistical analyses. M.Y.K. and D.W.L. drafted and revised the manuscript. M.Y.K., J.L., H.R.K., and D.W.L. and interpreted the data and provided critical revision of the manuscript. M.Y.K. supervised the study.

## DISCLAIMER

None.

## PATIENT CONSENT FOR PUBLICATION

Not required.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from Korean Health Panel Study at <https://www.khp.re.kr:444/eng/data/data.do>.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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