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Association of long working hours and health-related productivity loss, and its differential impact by income level: A cross-sectional study of the Korean workers

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Abstract

Objectives: We aimed to explore the association between long working hours and health-related productivity loss (HRPL), due to either sickness, absenteeism or presenteeism, stratified by household income level.

Methods: From January 2020 to February 2020, data were collected using a web-based questionnaire. A total of 4197 participants were randomly selected using the convenience sampling method. The nonparametric association between weekly working hours and HRPL was determined. Subsequently, a stratified analysis was conducted according to household income (1st, 2nd, and 3rd tertiles). Finally, the differences in HRPL of the different working hour groups (<40, 40, 40-51, and ≥52 hours) were investigated using a multivariate linear regression model.

Results: Long working hours were more significantly associated with HRPL, as compared to the 'standard' working hours (40 hours/week). A larger proportion of productivity loss was associated with the presenteeism of workers, rather than absenteeism. The relationship between HRPL and weekly working hours was more prominent in the lower household income group.

Conclusions: The results of our study indicate that HRPL is associated with long working hours, especially in the lower household income group. Reducing the workload for the individual employee to a manageable level and restructuring sick leave policies to effectively counteract absenteeism and presenteeism may be a feasible option for better labor productivity and employee health.

KEYWORDS

absenteeism, household income, presenteeism, productivity loss, working hours

1 | INTRODUCTION

The health of an individual is often their most important asset. Without optimum health, the basic activities of daily life, including the ability to work, are greatly affected. According to the theoretical framework of the human capital model, an individual's productivity at the workplace is directly proportional to his or her health status.[1] To increase

workplace productivity, and to enable employees to increase their earning potential, they should invest in personal health promotion. In contrast, negative impacts on the health of employees may adversely influence workplace productivity.

Therefore, the health status of workers is an important underlying factor in enhancing or maintaining productivity in the labor force.[2] Previously, numerous studies have demonstrated that poor health among employees is associated with decreased productivity.[3-9] Globally, health-related problems have led to a considerable loss in work hours as well as productivity.[10-12] Under the assumption that a causal relationship exists between the suboptimal health of employees and the resulting loss in productivity, approximately 7% of the productivity loss can be attributed to moderate functional limitations due to health-related problems.[13]

According to the human capital approach, productivity loss due to ill health is defined in terms of absenteeism (ie, failure to come to work) or presenteeism (ie, coming to work but exhibiting reduced performance). Steward et al observed that among workers with common pain conditions such as arthritis, headache, and musculoskeletal pain, productivity loss related to absence due to sickness and presenteeism due to sickness presenteeism corresponded to 3.5 and 5.5 hours per week respectively.[8] Of those, only the loss of approximately an hour resulted from absence due to sickness. The remainder was caused by reduced performance while at work. A similar result was observed among workers suffering from depression.[7] Van den Heuvel et al showed that among workers with upper extremity problems, productivity losses were mostly due to sickness presenteeism (57%-89%), and to a lesser extent due to sickness absenteeism (11%-43%).[6] Therefore, presenteeism due to sickness may strongly influence the indirect costs to society. For example, Li et al calculated that 41% of the costs of arthritis were attributed to reduced performance at work (ie., sickness presenteeism), whereas only 12% was attributed to a decrease in actual working hours (ie, sickness absence).[5]

Employee health is the most important factor influencing productivity loss. However, both qualitative and meta-analytic literature reviews suggest that a variety of factors may serve as determinants of productivity loss resulting from either absenteeism or presenteeism. These include individual factors (age, gender, and social economic status), work-related factors (physical and psychosocial working conditions), and societal factors (insurance coverage and unemployment rates).[3,13,14]

Unfavorable psychosocial employment characteristics, particularly associated with demanding jobs are likely to be accompanied by long working hours.[4,15] Recently, the relationship between the number of hours spent working in a week (work hours) and various health outcomes has been the focus of numerous studies.[16-19] Since productivity loss is closely related to health,[20] it stands to reason that longer work hours may also correlate with health-related productivity loss (HRPL).

The economic status of employees must also be considered when exploring the relationship between long working hours and health-related productivity. Given the budget and time constraints from the perspective of labor economics, individuals must allocate their time between work and leisure to maximize their utility.[21] Longer working hours are usually accompanied by a higher individual income. Because of the coexistence of the detrimental effects of long working hours on health and the protective effects of high-income status on health, it is important to consider individual income when investigating the association between working hours and health.[17,22] In fact, a recent study has investigated whether long working hours have different effects on workers' health, depending on the differences in their economic status.[23]

To develop effective health interventions and improve productivity, further research is required. However, studies exploring the relationship between working hours and HRPL are limited. Therefore, in this study we aimed to explore the association between long working hours and health-related productivity loss, due to either sickness absenteeism or presenteeism, stratified by household income level.

2 | MATERIALS AND METHODS

2.1 | Study participants

From the 6th of Jan 2020 to the 18th of Feb 2020, data were collected using a web-based questionnaire through Panelnow (https://www.panelnow.co.kr), which is an online panel survey service operated by DataSpring Korea Inc The target population comprised of employees aged 19 years or older. A total of 4197 participants were randomly selected using the convenience sampling method. After excluding non-waged workers (n = 307), the study participants were comprised of 3890 waged workers in South Korea. The survey was performed through an online system that ensured the completeness of the questionnaires. As a result, the data of the study participants did not contain missing information. This study was approved by the Institutional Review Board of the Catholic University of Korea, Catholic Medical Center, Seoul St, Mary's Hospital (KIRB-20200219-014).

2.2 | Measurement of health-related productivity loss

For the purpose of measuring loss of work productivity, estimation through a questionnaire is widely used in previous researches. Several measurement tools exist that assess absenteeism and presenteeism caused by health problems

on paid working days.[24] We addressed HRPL by using the "Work Productivity and Activity Impairment Questionnaire: General Health version"(WPAI:GH). The WPAI:GH consists of six items and can assess absenteeism, presenteeism, and work productivity loss due to health. Absenteeism, or the percentage of work time missed due to health problems in the past 7 days, was calculated as [hours missed form work because of health problems in the last week/(hours missed due to health problems + hours worked in the last week)]. Presenteeism, or the percentage of impairment experienced at work due to health problems in the past 7 days, was measured by the following question: "During the past seven days, how much did health problems affect your productivity while you were working?" Participants were asked to select a score on a scale of 0 (health problems had no effect on my work)-10 (health problems completely prevented me from working). The score was divided by 10 to calculate the percentage of productivity loss due to health problems in the last week. The percentage of overall HRPL was calculated as (absenteeism + presenteeism ×hours worked in the last week). The validity and reliability of the WPAI:GH has been verified.[25] The Korean version of the WPAI:GH was developed through independent translations, harmonization, back-translation, expert review, and was reviewed by local language users and tool developers.[26]

2.3 | Variable measurement

Information on demographic and socioeconomic characteristics, economic status, and health behaviors was collected. A self-reported questionnaire containing the following question was used to collect data regarding the weekly working hours of the participants: "How many hours do you work at your job per week on average, including overtime (except for meals)?" In accordance with the Labor Standard Act in South Korea, the weekly working hours of participants were classified into four groups as follows: <40 (shorter than the standard weekly working hours), 40 (standard and the most frequent weekly working hours), 40-51 (usually permitted overtime work), and ≥ 52 hours (overtime work allowed in extraordinary situations). The following question was used to assess household income: "What is [your] approximate gross household income over the last year, including labor in-come, real estate income, pensions, interest income, public income transfer, and private transactions from relatives and your family?" The household income level of participants was classified into three groups based on the tertiles of household income. Job classification was defined as white collar (chief executives, senior officials, legislators, managers, professionals, and technicians) or blue collar (clerks, clerical support workers, services and sales workers, craft and related trades workers, drivers, plant and machine operators, assemblers, elementary occupation workers, skilled agricultural, forestry, and fishery workers). Other information on factors including age, gender, level of education (≤High school, college, university, or graduate school), marital status (single, married, separated, widowed, or divorced), employment contracts (regular, temporary, or day laborer), shiftwork status (no or yes), smoking status (no or yes), binge drinking (more than once a month or not), and exercise (moderate exercise more than 150 min/week or not) were also collected using the questionnaire.

2.4 | Statistical analysis

First, we described the characteristics of the study participants. Based on these characteristics, the weekly working hours and HRPL variables (the percent overall HRPL, presenteeism, and absenteeism) were calculated and the differences were tested by demographic variables using the Student's *t*-test and ANOVA test. Next, the nonparametric associations between weekly working hours and HRPL variables were investigated using a smoothing spline curve and a generalized additive model according to household income (1st, 2nd, and 3rd tertiles). This nonparametric association was presented after stratification for gender. Given the results of the explored nonparametric association, the linear association between weekly working hours, household income, and the percentage of overall HRPL, presenteeism, and absenteeism were examined according to the working hours subgroups (≤40 hours and >40 hours) by using multivariate linear regression models. We tested the interaction effect of two variables in terms of the HRPL variables and household income by applying their interaction terms (HRPL variables × tertile of household income) in the multivariate linear regression models. Linear regression models were constructed separately by gender and job classification. Adjustment variables used in the models were selected a priori including age, education level, marital status, and employment contract. We performed additional analyses with the stratification for job classification (white collar vs. blue collar). All statistical analyses were performed using SAS (version 9.4; SAS Institute) and R version 3.4.4 (R Foundation for Statistical Computing). Two-tailed p values < 0.05 were considered to indicate statistical significance.

3 | RESULTS

Table 1 presents the demographic characteristics of the study participants. A total of 3890 waged workers included 1944 (50.1%) males and 1938 (49.9%) females. The average weekly working hours of the study participants were 42.4 hours (standard deviation [SD] ±11.4). The mean

TABLE 1 Demographic characteristics, weekly working hours and health-related productivity loss of the study participants

			Weekly working hours (hours)			Health-related productivity loss (Percent overall HRPL)			Percent impairment while working due to health (Presenteeism)			Percent work time missed due to health (Absenteeism)		
	n	(%)	mean	(SD)		mean	(SD)		mean	(SD)		mean	(SD)	
Total			42.4	(11.4)		26.6	(26.7)		25.7	(26.0)		1.9	(8.2)	
Gender														
Male	1944	(50.1)	45.1	(9.8)	**	24.5	(25.6)	**	23.7	(25.0)	*	1.5	(6.7)	*
Female	1938	(49.9)	39.7	(12.2)		28.7	(27.5)		27.7	(26.8)		2.2	(9.4)	
Age														
20-29	948	(24.4)	41.1	(13.4)	**	30.0	(27.6)	**	29.1	(26.8)	**	2.2	(9.5)	
30-39	1098	(28.3)	43.3	(10.6)		28.5	(26.7)		27.7	(26.2)		1.5	(6.6)	
40-49	1117	(28.8)	43.0	(10.4)		25.0	(26.5)		24.1	(25.8)		1.9	(8.5)	
50-59	522	(13.5)	41.9	(10.2)		21.8	(24.8)		20.9	(24.1)		2.0	(8.8)	
60~	197	(5.1)	41.3	(12.6)		21.5	(24.2)		20.5	(23.4)		1.7	(6.2)	
Education														
≤High school	748	(19.3)	40.5	(14.2)	**	26.9	(26.9)		25.6	(25.9)		2.5	(9.7)	*
College or University	2750	(70.8)	42.9	(10.7)		26.7	(26.5)		26.0	(26.0)		1.6	(7.4)	
Graduate school	384	(9.9)	42.4	(9.9)		25.3	(27.0)		24.2	(26.0)		2.5	(9.9)	
Household income (KRW, million)														
1st Tertile (–30)	1276	(32.9)	40.9	(13.4)	**	29.7	(27.4)	**	28.6	(26.7)	**	2.4	(9.8)	*
2nd Tertile (30-50)	1311	(33.8)	43.1	(10.6)		25.7	(26.1)		25.0	(25.5)		1.5	(7.0)	
3rd Tertile (51-75)	1295	(33.4)	43.3	(9.7)		24.5	(26.2)		23.7	(25.6)		1.6	(7.6)	
Marital status														
Single	1845	(47.5)	42.2	(12.5)		28.7	(26.9)	**	27.9	(26.3)	**	1.8	(8.3)	
Married	1870	(48.2)	42.8	(10.0)		24.7	(26.3)		23.8	(25.7)		1.8	(7.6)	
Separated	46	(1.2)	38.7	(14.5)		33.2	(30.0)		30.4	(28.2)		4.4	(15.0)	
Widowed	25	(0.6)	41.4	(13.2)		19.4	(22.1)		18.8	(21.7)		1.5	(6.0)	
Divorced	96	(2.5)	41.8	(11.9)		21.7	(24.0)		20.4	(23.3)		2.9	(12.0)	
Employment status														
Regular	3480	(89.6)	43.9	(9.6)	**	26.3	(26.5)		25.6	(25.9)		1.6	(7.6)	**
Temporary	310	(8.0)	30.0	(16.4)		27.9	(27.3)		26.5	(26.6)		2.8	(9.7)	
Day laborer	92	(2.4)	28.1	(16.8)		32.0	(30.4)		28.8	(27.6)		6.9	(17.5)	
Occupation														
White collar	2538	(65.4)	43.2	(9.0)	**	26.3	(26.4)		25.5	(25.9)		1.6	(7.1)	*
Blue collar	1344	(34.6)	41.0	(14.8)		27.2	(27.1)		26.1	(26.2)		2.4	(9.9)	
Shiftwork														
No	3247	(83.6)	42.8	(10.2)	**	26.3	(26.4)		25.4	(25.8)		1.7	(7.7)	*
Yes	635	(16.4)	40.5	(16.0)		28.2	(28.0)		27.1	(27.1)		2.6	(10.4)	
Smoking														
No	2878	(74.1)	41.5	(11.3)	**	27.0	(26.9)		26.1	(26.3)		1.9	(8.4)	
Yes	1004	(25.9)	45.0	(11.4)		25.5	(25.9)		24.5	(25.0)		1.8	(7.7)	

(Continues)

TABLE 1 (Continued)

	n	(%)	Weekly working hours (hours)			Health-related productivity loss (Percent overall HRPL)			Percent impairment while working due to health (Presenteeism)			Percent work time missed due to health (Absenteeism)	
			mean	(SD)		mean	(SD)		mean	(SD)		mean	(SD)
Binge drinking													
No	2850	(73.4)	41.2	(11.8)	**	27.6	(27.0)	*	26.0	(25.9)		1.9	(8.3)
Yes	1032	(26.6)	45.8	(9.3)		24.0	(25.4)		25.4	(26.1)		1.9	(8.1)
Exercise													
No	2973	(76.6)	42.2	(11.2)		27.1	(26.6)	*	26.3	(25.9)	*	1.9	(8.4)
Yes	909	(23.4)	43.0	(12.0)		24.9	(26.9)		23.9	(26.3)		1.9	(7.4)

Students' *t*-test or ANOVA was performed to test the difference.

Abbreviations: HRPL, health-related productivity loss; SD, Standard deviation.

*$P < .05$,

**$P < .001$

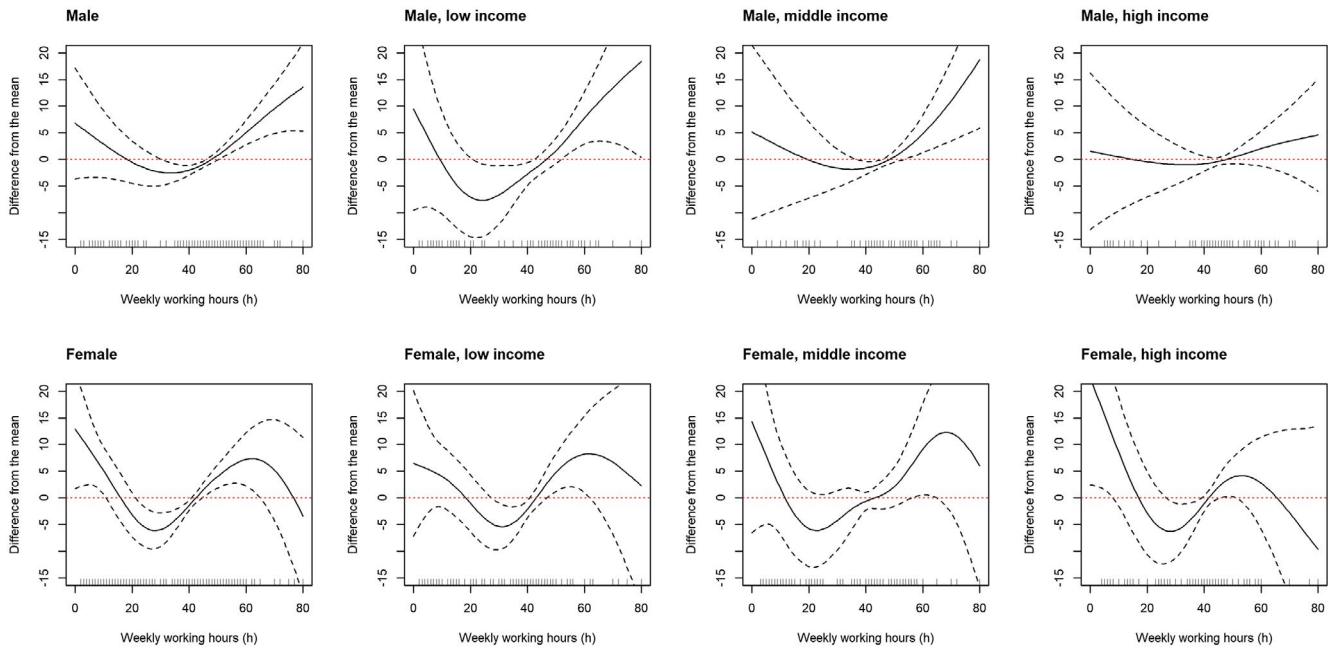

FIGURE 1 Nonparametric associations between weekly working hours and health-related productivity loss

values (±SD) of the percentage of overall HRPL, presenteeism, and absenteeism was 26.6% (±26.7), 25.7% (±26.0), and 1.9% (±8.2). Significantly longer weekly working hours were observed among participants with the following characteristics: male (vs female), age group (30-39 and 40-49), higher educational level, higher household income, employment contract (regular), job classification (white collar), shiftwork, current smoking, and binge drinking. On the other hand, HRPL was significantly higher among participants with the following characteristics: female sex, younger age group, lower household income, single or separated marital status, binge drinking, and exercise. Female sex, younger age, low household income, and single or separated marital status were similarly associated with higher presenteeism.

Figure 1 represents the nonparametric associations between the overall percentage of HRPL and weekly working hours. Among male workers, the results indicate that overall, the percent of HRPL is negatively associated with weekly working hours in the range of 0-40 hours/week, and it is positively associated with weekly working hours longer than 40 hours/week. In addition, the positive correlation between

the overall percentage of HPRL and working hours longer than 40 hours/week is greater in the lowest income tertile group than in the highest income tertile group. Among female workers, the overall percentage of HRPL was negatively associated with weekly working hours in the shorter weekly working hours classification, and positively associated with weekly working hours in the weekly working hours between 30 and 60 hours. Among the two designations of HRPL, absenteeism and presenteeism, these results were better explained by presenteeism than by absenteeism (Figure S1). The results, after stratifying for job classification, showed that this association was more prominent among white-collar workers (See Figure S2). Figure 2 represents the overall differences in HRPL, differences in HRPL across the working hour groups and those based on gender and household income. Among all subjects, those who worked 40-51 hours/week had a significantly higher HRPL of 2.4% points (95% confidence interval [CI]: 0.4, 4.4), as compared with those who worked 40 hours/week, with adjustment for potential confounders. Participants who worked 52 hours/week or longer had higher HRPL percentage points of 8.7% (95% CI: 4.1, 13.4), 5.0% (95% CI: 0.8, 9.1), and 5.2% (95% CI: 0.9, 9.5%) in the 1st, 2nd, and 3rd tertiles of the household income groups, respectively, as compared to those who worked 40 hours/week.

The results of multivariate linear regression analyses for weekly working hours and tertiles of household income and their impacts are shown in Table 2. Among male workers who worked longer than 40 hours/week, 1 hour of additional working time in a week was significantly associated with 0.722 percentage point increase in the percentage of overall HRPL. No significant association was found among female workers. There was no significant impact between the tertile of household income and weekly working hours on HRPL. However, negative interactions between weekly working hours and household income in the percentage of overall HRPL among white collar males and females who worked longer than 40 hours per week were observed. Among male and female white-collar workers who worked longer than 40 hours, an 1-hour increase in weekly working hours was associated with a 1.19% point ($P < .001$) and 0.35% point ($P = .014$) change in the percentage of overall HRPL respectively. The interaction between household income and weekly working hours on the percentage of overall HRPL was significant in white collar males ($\beta = -0.45$, $P = .014$) and white collar females ($\beta = -0.28$, $P = .022$). This pattern of association and interaction was not statistically significant among blue collar workers. In addition, these associations were better explained by presenteeism than by absenteeism. An hour increase in weekly working hours was associated with a 0.39%-point increase in the percentage of overall HRPL among blue collar male workers who worked > 40 hours/week. However, this association was not statistically significant ($P = .088$). Among women who were blue-collar workers and worked 40 hours or less, an hourly increase in weekly working hours was significantly associated with a −0.34% point change in the percentage of overall HRPL.

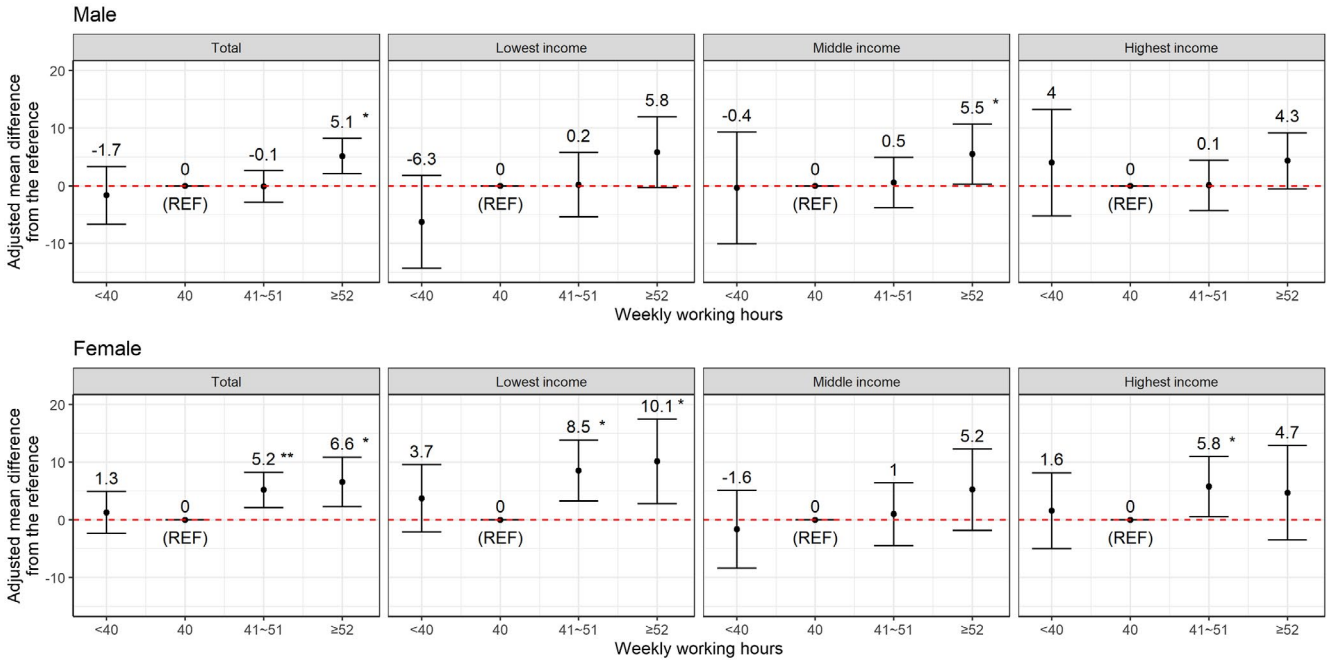

FIGURE 2 Adjusted differences in work productivity impairment according to weekly working hours. *Note*. Mean differences from the reference group (weekly working hours = 40 h/week) by the weekly working hours group (<40 h/week, 41-51 h/week, ≥52 h/week) were depicted, with an adjustment for gender, age, education level, marital status, and employment contract. $^{*}P < .05$, $^{**}P < .001$

TABLE 2 Results of multivariate linear regression model with interaction terms for the association of health-related productivity loss with weekly working hours and household income

	Health-related productivity loss (Percent overall HRPL)						Percent impairment while working due to health (Presenteeism)						Percent work time missed due to health (Absenteeism)					
	0-40 h/week (n = 2062)			>40 h/week (n = 1820)			0-40 h/week (n = 2062)			>40 h/week (n = 1820)			0-40 h/week (n = 2062)			>40 h/week (n = 1820)		
	β	SE	*P*	*β*	SE	*P*	*B*	SE	*P*	*β*	SE	*P*	*β*	SE	*P*	*β*	SE	*P*
Male (n = 1944)																		
Weekly working hour (hours)	0.094	0.194	.628	**0.722**	**0.182**	**<.001**	0.164	0.180	.361	**0.676**	**0.177**	**<.001**	-0.120	0.091	.188	0.063	0.071	.373
Tertile of household income	1.278	6.113	.835	5.692	6.868	.407	3.244	5.865	.580	4.653	6.723	.489	-3.890	1.981	.050	0.547	2.482	.826
Interaction term	−0.107	0.162	.510	−0.197	0.135	.145	−0.160	0.156	.305	−0.168	0.133	.207	0.105	0.051	.041	−0.024	0.051	.636
Male, White collar (n = 1257)																		
Weekly working hour (hours)	−0.37	0.38	.338	**1.19**	**0.27**	**<.001**	−0.32	0.38	.401	**1.14**	**0.27**	**<.001**	−0.16	0.12	.199	0.12	0.13	.330
Tertile of household income	**−19.35**	**9.57**	**0.043**	17.63	9.09	.052	**−18.72**	**9.47**	**.048**	16.05	9.02	.075	−4.05	3.34	.225	3.91	3.69	.289
Interaction term	0.39	0.25	0.114	**−0.45**	**0.18**	**.014**	0.37	0.25	.128	**−0.41**	**0.18**	**.024**	0.11	0.09	.200	−0.09	0.07	.227
Male, Blue collar, m (n = 687)																		
Weekly working hour (hours)	0.18	0.20	.365	0.39	0.23	.088	0.25	0.18	.169	0.35	0.23	.123	−0.08	0.09	.352	0.01	0.08	.855
Tertile of household income	7.96	6.86	.246	0.71	10.66	.947	9.87	6.57	.133	0.20	10.45	.985	−2.98	1.59	.060	−3.39	3.97	.393
Interaction term	−0.23	0.20	.241	−0.09	0.20	.665	−0.29	0.19	.132	−0.07	0.20	.742	0.08	0.05	.083	0.05	0.08	.536
Female (n = 1938)																		
Weekly working hour (hours)	−0.233	0.120	.052	0.056	0.170	.742	−2.272	3.690	.538	0.069	0.170	.682	**−0.183**	**0.061**	**.003**	−0.038	0.024	.107
Tertile of household income	−1.385	4.063	.733	7.668	6.814	.261	0.040	0.101	.690	8.093	6.765	.232	1.069	2.624	.684	−1.713	1.287	.183
Interaction term	0.020	0.111	.855	−0.193	0.135	.152	1.454	2.030	.474	−0.198	0.134	.140	−0.023	0.069	.738	0.023	0.024	.352
Female, White collar (n = 1281)																		
Weekly working hour (hours)	−0.09	0.20	.669	**0.35**	**0.12**	**.003**	−0.03	0.19	.863	**0.35**	**0.12**	**.003**	−0.18	0.10	.084	−0.01	0.02	.765
Tertile of household income	1.92	7.19	.790	11.59	6.25	.064	−2.76	6.42	.667	11.22	6.27	.074	3.23	5.12	.529	−0.27	1.22	.825

(Continues)

TABLE 2 (Continued)

	Health-related productivity loss (Percent overall HRPL)						Percent impairment while working due to health (Presenteeism)						Percent work time missed due to health (Absenteeism)					
	0-40 h/week (n = 2062)			>40 h/week (n = 1820)			0-40 h/week (n = 2062)			>40 h/week (n = 1820)			0-40 h/week (n = 2062)			>40 h/week (n = 1820)		
	β	SE	*P*	*β*	SE	*P*	*B*	SE	*P*	*β*	SE	*P*	*β*	SE	*P*	*β*	SE	*P*
Interaction term	−0.09	0.19	.649	**−0.28**	**0.12**	**.022**	0.03	0.17	.852	**−0.27**	**0.12**	**.028**	−0.08	0.13	.530	0.00	0.02	.961
Female, Blue collar (n = 657)																		
Weekly working hour (hours)	**−0.34**	**0.15**	**.027**	−0.20	0.15	.167	−0.24	0.14	.092	−0.18	0.15	.244	**−0.18**	**0.07**	**.014**	−0.06	0.04	.188
Tertile of household income	−2.84	4.87	.559	6.41	10.92	.557	−2.00	4.47	.655	7.30	10.79	.499	0.18	2.77	.948	−1.32	3.54	.709
Interaction term	0.10	0.15	.480	−0.15	0.21	.482	0.08	0.14	.567	−0.16	0.20	.438	0.00	0.08	.964	0.01	0.07	.912

Adjusted for gender, age, education level, marriage status, and employment contract.

$P < .05$ in bold.

Abbreviations: HRPL, health-related productivity loss; SE, standard error.

4 | DISCUSSION

The results of our study indicate that HRPL is associated with long working hours, and the association correlates with household income. The associations were complex and differed across multiple factors including weekly working hours, household income, gender, and job classification. Long working hours were more significantly associated with HRPL, as compared to the "standard" working hours (40 hours/week). A larger proportion of productivity loss was associated with the presenteeism of workers, rather than absenteeism. HRPL and weekly working hours were significantly associated, and this association was characterized by an interaction with household income, especially among white collar workers.

It is widely known that Henry Ford adopted a 40-hour workweek in 1926, almost a century ago.[27] His experiments, which were conducted for at least 12 years, revealed that reducing the workday from 10 to 8 hours, and the workweek from 6 to 5 days, increased total worker output and reduced production costs. Ford spoke vividly of the social benefits of a shorter workweek. He argued that a reduced shift length resulted in additional output.[28] Consequently, this implied that reduced working time was good for everyone. Since then, numerous studies have been conducted by businesses, universities, industry associations, and the military. These studies support the basic notion that, for most people, 8 hours a day, 5 days per week, is the best sustainable long-term balance point between output and exhaustion.[27]

Most workers are able to maintain consistent productivity when working for 40 hours per 5-day workweek. However, ironically, productivity begins to decline with long working hours. A hundred years of industrial research has proven that longer hours at work do not increase output, except in the short term.[29,30] Somewhere between a period of 4 days to 2 months, the gains from additional hours of work are diminished by the decline in hourly productivity.[31]

There are several possible mechanisms underlying the relationship between long work hours and HRPL. First, both physical and mental health problems caused by long working hours facilitate productivity loss. This indicates that because long working hours are closely associated with health problems such as hypertension, diabetes, cardiovascular disease, stress, anxiety, depression, and occupational injury, this in turn leads to absenteeism and presenteeism. Second, lack of recovery time from work plays an important role in HRPL. If an adequate period of recovery time does not exist between work shifts, it may lead to work-induced fatigue. Consequently, the risk of ill health, absenteeism, and presenteeism may increase. The recuperative value of sleep depends upon its duration and continuity, and long working hours that continue late into the night, may negatively impact restorative sleep.[32] Empirical findings in the laboratory and the field suggest that sleep deprivation impairs alertness, mood, and cognitive performance.[33-35] Third, long working hours adversely affect work-life balance. Previous research has indicated that poor work-life balance is associated with increased health problems.[36] An experimental study performed at a large hospital in Sweden revealed that reduced working hours are closely correlated with improved work-life balance and improved job performance.[37] Fourth, long working hours may cause burnout, leading to deterioration of performance. Grawitch et al argued that if work demands subsequently require more time and energy than desired, employees lose motivation for their work. This leads to a decrease in efficiency and results in decreased productivity.[38]

It is notable that HRPL was more prominently associated with long working hours in the low-income group, as compared to the high-income group. This finding provides new information about the effects of long working hours on labor productivity. However, this does not imply that long working hours have a smaller impact on the health of the high-income population. In general, longer working hours are accompanied by higher individual income. From the perspective of labor economics, individuals make time allocation decisions between work and leisure to maximize their utility, given their budget and time constraints.[21] Even in cases of ill health, some individuals with low incomes may accept job offers with longer working hours to maintain a sufficient income at the expense of leisure time. This inevitably causes a greater degree of presenteeism. On the other hand, workers with high incomes may want to work fewer hours if their wages are high enough to make a living without overtime work. They may trade work hours for leisure hours in an attempt to maximize their utility and reduce the time they spend at work. Furthermore, high-income workers tend to have more creative stimulating jobs, with greater autonomy regarding the regulation of their working time. Low-income workers often have unmotivating, monotonous, physically demanding jobs, with less autonomy and therefore lower quality. These differences in working conditions can contribute to differences in the response to long working hours,[23,39] which affects health and productivity differently. In our analysis, the relationship between long working hours and HRPL is most prominent among low-wage white collar workers (Figure S2). Given this complex, multidimensional etiology, further longitudinal studies with comprehensive information on working conditions are required to clarify the causal influence of hazardous work-related factors on HRPL. However, due to the lack of data, we could not test the impact of working conditions in our analysis.

Some limitations of this study must be taken into consideration. First, the cross-sectional design of the study does not permit further explanation of the causal relationship. Second, the data collection was based on convenience samples taken through an online survey. It is possible that the estimates derived from the sample are biased. For example, the study population contains just 5.1% of "over 60s workers." This value is only a quarter of the actual population

composition in South Korea. Therefore, if the sample does not accurately represent the target population, the sample estimate may not reflect the actual effect among the target populations. Third, although self-reported data on HRPL are usually considered reliable and valid,[24] the measurement of impairment at work remains a major challenge for research. Finally, the method of HRPL assessment in the current study did not permit us to differentiate between specific health problems. This would have been useful for the development of preventive strategies.

Nevertheless, this study benefits from several unique features. The strength of this study lies in the use of a large diverse sample with approximately 4000 participants in the exploration of the relative influence of long working hours on productivity loss among workers in Korea. In addition, the online survey method is able to efficiently capture data from a larger and more diverse population for better generalization of findings.

Beyond the current study, future research should include a more objective measurement of HRPL. In addition, intervention studies could assist in the evaluation and development of HRPL prevention programs that help improve workers' health and productivity.

This study has implications for employers to improve workplace productivity. The results regarding productivity loss by long working hours can help employers to set a more productive workflow. Thus, the reduction in working hours for the individual employee would be manageable. From a more practical point of view, the results of our study can be applied to organizations in terms of how they structure their working hours and sick leave policies. Employers should approach reduced working hours and sick leave as opportunities for recovery.[4] When employees spend sufficient time recovering from an illness or injury, recovery time can be shortened thereby minimizing sickness presenteeism, which eventually decreases the total amount of productivity lost overall. Therefore, restructuring sick leave policies to effectively balance absenteeism and presenteeism may be a feasible option for better labor productivity.

5 | CONCLUSION

The results of the current study provide evidence regarding the role of long working hours as antecedents of HRPL by investigating the correlation between absenteeism and presenteeism, especially among workers with low incomes. Based on the results of this study, it may be stated with confidence that long working hours are not only an unhealthy, but also an uneconomical choice for an organization. We hope that awareness of the magnitude of these losses will encourage employers and policymakers to adopt productive and health promoting management strategies.

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DISCLOSURES

Ethical approval: This study was approved by the Institutional Review Board of the Catholic University of Korea, Catholic Medical Center, Seoul St, Mary's Hospital (KIRB-20200219-014). *Informed consent:* All participants provided written informed consent for participation in the study. *Registry and the Registration No. of the study/Trial:* N/A. *Animal Studies:* N/A.

CONFLICT OF INTEREST

The authors declare that we have no competing interests.

AUTHOR CONTRIBUTIONS

MYK conceived and designed the study. DWL conducted the statistical analyses. MYK and DWL drafted the manuscript. MYK, JL, HRK, and DWL interpreted the data and critically revised the manuscript. MYK supervised the study.

DATA AVAILABILITY STATEMENT

Data are available upon reasonable request. Procedures for accessing study data are available through contacting the study team. Any proposals for collaborative analyses are given due consideration.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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