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Research Article

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Association of work–life balance with occupational injury and work-related musculoskeletal pain among Korean workers

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Abbreviations
CI: confidence interval; EWCS: European Working Conditions Surveys; KWCS: Korean

ABSTRACT

Background: The concept of work-life balance (WLB) has become an important issue in workers' health and safety. This study aims to investigate the relationship between WLB and occupational injury and work-related musculoskeletal pain.
Method: The study included 27,383 workers who participated in the Fifth Korean Working Conditions Survey. Participants were divided into good WLB and poor WLB groups based on their responses to the five question items which comprised two dimensions: work-on-life conflict (items, 1–3) and life-on-work conflict (items 4 and 5). Occupational injury and musculoskeletal pain were also assessed using the question items. The χ^2 test and multivariate logistic regression analyses were performed to examine the relationship of WLB to occupational injury and musculoskeletal pain while considering socio-demographic and occupational characteristics and ergonomic and psychological risk factors.
Results: Of the 27,383 participants, 252 (0.9%) had experienced an occupational injury and 6,408 (23.4%) had musculoskeletal pain. The poor WLB group had higher injury rates for both men (1.7%) and women (0.9%) than the good WLB group (1.1% and 0.4%, respectively). Additionally, the prevalence of musculoskeletal pain was higher for both men and women in the poor WLB group (25.2% and 28.0%, respectively) than for men and women in the good WLB group (18.7% and 23.6%, respectively). In the logistic regression analysis, the adjusted odds ratio of WLB for occupational injury was 1.37 (95% confidence interval [CI]: 1.06–1.78), and that for musculoskeletal pain was 1.14 (95% CI: 1.07–1.21), showing positive associations of WLB with both occupational injury and musculoskeletal pain.
Conclusions: Poor WLB causes an increase in occupational injury and musculoskeletal pain. Therefore, an improvement in WLB may reduce the incidence of occupational injury and musculoskeletal pain among workers. Social and policy-related initiatives are needed to improve workers' WLB to reduce occupational injury and musculoskeletal pain.

Keywords: Work-life balance; Occupational injury; Work-related musculoskeletal pain

INTRODUCTION

In recent years, much attention has been focused on the problems affecting the quality of work and family life, and the associated implications for occupational health. As a result,

Working Conditions Surveys; LWC: life-on-work conflict; OR: odds ratio; PC: personal computer; WLB: work-life balance; WLC: work-on-life conflict.

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Competing interests

The authors declare that they have no competing interests.

Authors contributions

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new concepts, such as work–family conflict or interference, work-family accommodation, work-family compensation, work-family segmentation, work-family enrichment, work-family expansion, and work-family balance have emerged [1]. We use the term "work-life balance" (WLB), rather than work-family balance or work-family conflict, in consideration of all employed individuals regardless of their marital or parental status, to broaden the scope of the term, as well as to ensure the diversity of the sample being studied [2].

There is no single, concrete definition or measurement of WLB. Multiple studies have used different definitions of WLB, such as: "an adequate amount of resources to respond effectively to the demands of work and family roles" [3], "balancing the life demands of various life-roles" [4], and "conflict between work and life or clashing of work and life" [5]. The European Agency for Safety and Health at Work defines WLB as the "extent to which an individual is equally engaged in and equally satisfied with his or her work and family roles," making reference to a review by Greenhaus and Allen [6].

According to a Statistics Korea report, the number of double-income households increased from 5,241 in 2011 to 5,456 in 2017. Further, female participation in economic activities increased from 50.3% in 2013 to 52.7% in 2017 [7]. As a result of the growth in female economic participation, the focus in society has shifted from women engaging exclusively in family roles to women engaging in both family and social roles. This engenders a conflict between work roles and life or family roles. Moreover, the average working week decreased from 46 hours in 2011 to 42.8 hours in 2017 [7]. Further, the percentage of people who engage in self-improvement activities for at least three hours per week increased from 6.6% in 2014 to 14.1% in 2017 [7]. Expenditure on leisure and cultural activities has increased from 4.13% in 2011 to 5.27% in 2017 [8]. As a result of the decrease in weekly working hours and the increasing time spent on self-improvement and leisure activities, there is evidence that workers increasingly value their life roles, whereas previously, workers used to spend most of their time fulfilling work roles. Amid societal changes, such as increased women's economic participation, decreased working hours, and increased leisure time, WLB has become an important issue for modern-day Korean workers.

Most previous studies of WLB have investigated its association with psychosocial factors. In a 2018 study, poorer WLB was associated with poorer psychosocial wellbeing among Korean workers [9]. A study that investigated the association between WLB and job satisfaction reported that job satisfaction decreased with higher work–life conflict, that is, lower WLB [10]. Further, studies have reported that WLB is associated with anxiety, substance abuse, substance dependence [11], burnout [12], and poor self-rated health [13], indicating that WLB is a factor in psychosocial wellbeing. Thus, it is important to investigate its relevance to the aforementioned mental health issues, as well as to examine the physical problems associated with poor WLB.

Occupational injury and musculoskeletal pain are the most important and common problems associated with work-related physical health problems. Occupational injury refers to injury that occurs due to an accident at work. It may lead to pathological conditions, disabilities, and early mortality, which are associated with decreased life expectancy and increased costs for society [14]. More than 350,000 people worldwide are reported to die from occupational injuries [15].

Work-related musculoskeletal disorder (hereinafter musculoskeletal disorder) is the most common work-related health problem in most countries [16]. Particularly, it accounts for

more than 50% of occupational diseases in Europe [16], is a major source of lost work time and disability [17], and is thus associated with reduced productivity in society [18]. Despite numerous studies on the impact of WLB on workers' health, studies on the association of WLB with occupational injury and musculoskeletal pain are limited. Thus, the present study aimed to investigate WLB as a risk factor for occupational injury and musculoskeletal pain.

METHODS

Participants

This study analyzed data of workers who participated in the Fifth Korean Working Conditions Survey (Fifth KWCS) [19], which is a nationally representative cross-sectional survey. The KWCS, which was adapted from the European Working Conditions Survey (EWCS) [20], has been conducted by the Korean Occupational Safety and Health Research Institute since 2017. The target population of KWCS comprised employed individuals residing in Korea, aged 15 years or older at the time of the survey. The survey population was based on the 2010 Population and Housing Census, and reflected the characteristics of 50,000 employed individuals aged 15 years and older residing in apartment and general enumeration districts. The survey was conducted through one-on-one interviews with household members during house visits. An electronic questionnaire provided on a tablet PC was used for the survey. A total of 50,205 people were surveyed in the Fifth KWCS. Data from respondents who were unpaid workers, soldiers, employers, or unemployed, and from individuals who refused to answer WLB-related questions or provided missing responses (totaling 13,073 and 9,749, respectively), were excluded. A total of 27,383 individuals was included in the study.

Variables

The WLB scale, comprised 5 items as follows: 1) I worry about work even when I am not working; 2) I am so tired after work that I cannot do housework; 3) I am not able to spend enough time with my family due to work; 4) I do not have enough time to work because of problems at home; 5) I feel that I have less time for work because of family responsibilities. The 5 items were divided into 2 dimensions: work-on-life conflict (WLC; items 1 to 3), which occurs when work affects family and social life, and life-on-work conflict (LWC; items 4 and 5), which consists of life conflicts that affect work. Each item was rated on a 5-point Likert scale (never = 1, rarely = 2, sometimes = 3, mostly = 4, and always = 5), and the scores across all five items were summated. The total scores ranged from 5 to 25, and the median score of 11 was set as the cut-off value to categorize participants into the good WLB and poor WLB groups. In addition, based on the total scores, we divided WLB status in quartiles as follows: best WLB (25%), good WLB (50%), poor WLB (75%), and worst WLB (100%), and compared the differences based on quantitative changes. For each of the two dimensions of the scale (WLC and LWC), participants were also classified, based on the median value, into low conflict and high conflict groups. The Cronbach's alpha for the WLB scale comprising the 5 questions was 0.83, indicating adequate internal consistency [21].

Socio-demographic characteristics included participants' gender, age, education level, and income. Age was divided into ≤ 29 years, 30–39 years, 40–49 years, 50–59 years, and ≥ 60 years. Education level was divided into middle school graduate or below, high school graduate, and college graduate or above. Income was grouped into 10,000 Korean won/month units and was allocated as < 200, 200–299, 300–399, and ≥ 400 (1,227 Korean won = 1 US dollar, updated 01/06/20).

Occupational characteristics include occupation type, working hours per week, number of employees in the workplace, employment status, and shift work. The KWCS data investigated 10 occupation types, excluding soldiers. Occupations were classified into 3 categories: white-collar (managers, professionals, technicians and semi-experts, and office workers), service workers (service workers, including sales workers), and blue-collar (skilled agricultural and fishery workers; functional workers; equipment and machinery handlers, and assembly workers; and simple laborers). Using the Korean standard of a 40-hour working week, and 52 hours including overtime, working hours per week was grouped into ≤ 40 hours, 41–52 hours, and ≥ 53 hours. Number of employees was divided into 1–9, 10–249, and ≥ 250. Employment status was grouped into full-time, part-time, or temporary worker. Shift work was determined by the "yes" or "no" response to the statement, "I work shifts."

An index of ergonomic risk factors was generated by answering the four questions: vibration exposure; fatigue-inducing or painful posture; dragging, pushing, or moving heavy objects and repetitive hand or arm movements. There were 7 levels of exposure to each question, namely: no exposure at all, hardly any exposure, one quarter of the working hours, one half of the working hours, three quarters of the working hours, almost the entire working hours, and the entire working hours. Each question was categorized into dichotomous variables; non-exposure (exposed for one quarter or less of the working hours) and exposure (exposed for half or more of the working hours). An index of ergonomic risk factors were classified into groups that were not exposed to any of the four question ("Non-exposure") and those that were exposed to one or more of them ("Exposure").

Two questionnaire items were used to identify the psychological risk factor. To the question "Have you suffered from the following health problems during the past 12 months?" with the option of "depression" and "anxiety," the two response options provided were "yes" and "no." Participants who responded "yes" were considered to have experienced the subjective symptoms of either depression or anxiety. Psychological factors were then classified into groups that reported no symptoms of depression and anxiety ("No"), and those that had experienced one or more of them ("Yes").

Occupational injury and musculoskeletal pain were assessed using the question, "Over the last 12 months, have you suffered from any of the following health problems: injury, upper limb pain (including shoulder, neck, arm, elbow, wrist and hand), back pain, lower limb pain (including hip, leg, knee and foot)?" Those who answered "yes" were additionally asked "Did the health problem occur as a result of your work?" Individuals who responded "Yes" were defined as having occupational injury and musculoskeletal pain. Musculoskeletal pain was assessed in terms of upper limb pain, back pain, and lower limb pain, and people with any of the three types of pain were considered to have musculoskeletal pain.

Statistical analysis

The χ^2 test was performed to examine the relationship between WLB and socio-demographic and occupational characteristics, as well as the relationship of occupational injury and musculoskeletal pain with socio-demographic and occupational characteristics. In addition, the adjusted odds ratio (OR) and 95% confidence interval (CI) were calculated using a multivariate logistic regression analysis to determine the relationship of WLB with occupational injury and musculoskeletal pain. We used unweighted frequencies of KWCS raw data for the analysis. A p-value ≤ 0.05 was considered to indicate statistical significance. Data were analyzed using SPSS (version 26.0; IBM Corp., Armonk, NY, USA).

RESULTS

Table 1 presents the characteristics of the participants based on their WLB status. Of the participants, 16,374 (59.8%) and 11,009 (40.2%) were categorized into good WLB and poor WLB groups, respectively. There were no significant differences in the proportions of male (39.9%) and female (40.5%) participants with poor WLB status. WLB status differed by age, and the prevalence of poor WLB was the highest (43.0%) among those aged 40–49 years. In terms of education level, WLB was the poorest (42.0%) among the high school group. WLB also differed by monthly income, wherein the prevalence of poor WLB was the highest (44.8%) for the 200–299 group. Regarding occupation type, WLB was the poorest (44.5%) among the service workers group. For working hours per week, a higher proportion of participants with longer work time rated their WLB as poor. In terms of the number of employees, WLB was the poorest among participants working in companies with 1–9 employees (41.0%), followed by those working in 10–249 employees (39.8%) and those

Table 1. Characteristics of study participants according to WLB status

Variables	Total	Good WLB	Poor WLB	*p*-value[a]
Total	27,383 (100.0)	16,374 (59.8)	11,009 (40.2)	
Socio-demographic characteristics				
Sex				0.339
Male	13,145 (48.0)	7,899 (60.1)	5,246 (39.9)	
Female	14,238 (52.0)	8,475 (59.5)	5,763 (40.5)	
Age group				0.001
≤ 29	3,535 (12.9)	2,253 (63.7)	1,282 (36.3)	
30–39	6,259 (22.9)	3,629 (58.0)	2,630 (42.0)	
40–49	7,299 (26.7)	4,162 (57.0)	3,137 (43.0)	
50–59	6,374 (23.3)	3,666 (57.5)	2,708 (42.5)	
≥ 60	3,916 (14.3)	2,664 (68.0)	1,252 (32.0)	
Education level				0.000
Middle school or below	3,230 (11.8)	2,175 (67.3)	1,055 (32.7)	
High school	9,536 (34.8)	5,527 (58.0)	4,009 (42.0)	
College or above	14,597 (53.3)	8,660 (59.3)	5,937 (40.7)	
Monthly income (10,000 Korean won)				0.001
< 200	10,096 (33.8)	6,551 (64.9)	3,545 (35.1)	
200–299	7,484 (28.2)	4,129 (55.2)	3,355 (44.8)	
300–399	4,740 (19.3)	2,671 (56.4)	2,069 (43.6)	
≥ 400	3,321 (18.7)	1,955 (58.9)	1,366 (41.1)	
Occupational characteristics				
Occupation type				0.000
White-collar	10,805 (39.6)	6,588 (61.0)	4,217 (39.0)	
Service workers	8,080 (29.6)	4,487 (55.5)	3,593 (44.5)	
Blue-collar	8,389 (30.8)	5,213 (62.1)	3,176 (37.9)	
Working hours per week				0.000
≤ 40	16,278 (59.6)	10,661 (65.5)	5,617 (34.5)	
40–52	7,399 (27.1)	4,083 (55.2)	3,316 (44.8)	
≥ 53	3,650 (13.4)	1,601 (43.9)	2,049 (56.1)	
Number of employees				0.036
1–9	11,778 (43.4)	6,944 (59.0)	4,834 (41.0)	
10–249	13,163 (48.5)	7,930 (60.2)	5,233 (39.8)	
≥ 250	2,215 (8.2)	1,340 (60.5)	875 (39.5)	
Employment status				0.000
Full-time worker	21,401 (78.2)	12,355 (57.7)	9,046 (42.3)	
Part-time or temporary worker	5,982 (21.8)	4,019 (67.2)	1,963 (32.8)	
Shift work				0.000
No	23,992 (87.6)	14,523 (60.5)	9,469 (39.5)	
Yes	3,386 (12.4)	1,849 (54.6)	1,537 (45.4)	

WLB: work-life balance.
[a]χ^2 test.

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working in companies with 250 employees or more (39.5%). Regarding employment status, a higher rate of participants in the full-time worker group (42.3%) had poor WLB than in the part-time or temporary worker group (32.8%). Finally, the prevalence of poor WLB was higher among shift workers (45.4%) than among non-shift workers (39.5%).

The prevalence rates of occupational injury and musculoskeletal pain were 0.9% and 23.4%, respectively. The prevalence of injury was lower among women (0.6%) than among men (1.3%), while that of musculoskeletal pain was higher among women (25.3%) than among men (21.3%). In terms of age, the prevalence of injury and musculoskeletal pain increased with age, with those aged 50–59 years reporting the highest prevalence of injuries (1.1%), and those aged ≥ 60 years the highest prevalence of musculoskeletal pain (33.2%). The prevalence of injury and musculoskeletal pain decreased with increasing education levels. In terms of income, the prevalence of injury was the highest for the 300–399 group (1.4%), and that of musculoskeletal pain decreased with higher income.

Regarding occupation types, the prevalence of injury and musculoskeletal pain was the highest among the blue-collar group (injury: 1.7%, musculoskeletal pain 35.3%). The prevalence of injury and musculoskeletal pain increased with increasing working hours; prevalence rates of injury (1.9%) and musculoskeletal pain (34.1%) were the highest among those who worked 53 hours or more a week. The prevalence of injury did not differ by the number of employees, but that of musculoskeletal pain decreased with a higher number of employees. In terms of employment status, the prevalence of injury (1.2%) and musculoskeletal pain (30.0%) was higher among part-time or temporary workers compared to full-time workers (injury: 0.8%, musculoskeletal pain: 21.6%). The prevalence of injury did not differ according to shift work, but that of musculoskeletal pain was higher among shift workers (27.8%) than among non-shift workers (22.8%).

Regarding the ergonomic risk factors, the prevalence of injury and musculoskeletal pain was higher among the exposure group (injury: 1.3%, musculoskeletal pain: 29.6%) than the non-exposure group (injury: 0.3%, musculoskeletal pain 11.9%). Finally, the prevalence of injury and musculoskeletal pain was high in groups with psychological risk factors (injury: 5.0%, musculoskeletal pain: 55.0%) (**Table 2**).

The poor WLB group had higher injury rates for both men (1.7%) and women (0.9%) than those of the good WLB group. The prevalence of injury increased with decreasing WLB for both men and women. Further, in terms of the two dimension of WLB, WLC and LWC, the prevalence of injury among men was higher in the high WLC group (1.9%) than among the low WLC group (1.2%), and the same was found for women (0.9% vs. 0.4%). There were no differences in injury rates with respect to LWC for both men and women (**Table 3**).

The prevalence of musculoskeletal pain was higher for both men and women in the poor WLB group (25.2% and 28.0%, respectively) than in the good WLB group (18.7% and 23.6%, respectively). The prevalence of musculoskeletal pain in men was 16.6%, 20.2%, 26.2%, and 24.5% for the best, good, poor, and worst groups, respectively, indicating the highest prevalence in the poor group. The prevalence of musculoskeletal pain in women was 19.9%, 26.4%, 32.1% and 25.3% for the best, good, poor, and worst groups, respectively, indicating that the prevalence of musculoskeletal pain among women was also the highest for the poor group. For men, those in the high WLC group reported higher musculoskeletal pain (26.1%) than did those in the low WLC group (18.5%), and the same was found for women (28.8%

Table 2. Prevalence of occupational injury and work-related musculoskeletal pain

Variables	Total	Occupational injury		Work-related musculoskeletal pain	
	No. (%)	Yes (%)	*p*-value[a]	Yes (%)	*p*-value[a]
Total	27,383 (100.0)	252 (0.9)		6,408 (23.4)	
Sex			0.000		0.000
Male	13,145 (48.0)	170 (1.3)		2,799 (21.3)	
Female	14,238 (52.0)	82 (0.6)		3,609 (25.3)	
Age group			0.005		0.000
≤ 29	3,535 (12.9)	16 (0.5)		437 (12.4)	
30–39	6,259 (22.9)	53 (0.8)		1,058 (16.9)	
40–49	7,299 (26.7)	75 (1.0)		1,654 (22.7)	
50–59	6,374 (23.3)	68 (1.1)		1,959 (30.7)	
≥ 60	3,916 (14.3)	40 (1.0)		1,300 (33.2)	
Education level			0.000		0.000
Middle school or below	3,230 (11.8)	44 (1.4)		1,320 (40.9)	
High school	9,536 (34.8)	112 (1.2)		2,829 (29.7)	
College or above	14,597 (53.3)	95 (0.7)		2,252 (15.4)	
Monthly income (10,000 Korean won)			0.000		0.000
< 200	10,096 (33.8)	64 (0.6)		2,735 (27.1)	
200–299	7,484 (28.2)	69 (0.9)		1,698 (22.7)	
300–399	4,740 (19.3)	68 (1.4)		898 (18.9)	
≥ 400	3,321 (18.7)	38 (1.1)		584 (17.6)	
Occupation type			0.000		0.000
White-collar	10,805 (39.6)	54 (0.5)		1,524 (14.1)	
Service workers	8,080 (29.6)	56 (0.7)		1,906 (23.6)	
Blue-collar	8,389 (30.8)	142 (1.7)		2,963 (35.3)	
Working hours per week			0.000		0.000
≤ 40	16,278 (59.6)	101 (0.6)		3,243 (19.9)	
40–52	7,399 (27.1)	79 (1.1)		1,900 (25.7)	
≥ 53	3,650 (13.4)	71 (1.9)		1,244 (34.1)	
Number of employees			0.194		0.000
1–9	11,778 (43.4)	103 (0.9)		2,957 (25.1)	
10–249	13,163 (48.5)	132 (1.0)		2,947 (22.4)	
≥ 250	2,215 (8.2)	14 (0.6)		429 (19.4)	
Employment status			0.015		0.000
Full-time worker	21,401 (78.2)	181 (0.8)		4,616 (21.6)	
Part-time or temporary worker	5,982 (21.8)	71 (1.2)		1,792 (30.0)	
Shift work			0.841		0.000
No	23,992 (87.6)	221 (0.9)		5,466 (22.8)	
Yes	3,386 (12.4)	30 (0.9)		940 (27.8)	
Ergonomic risk factors			0.000		0.000
Non-exposure	9,579 (35.0)	28 (0.3)		1,139 (11.9)	
Exposure	17,804 (65.0)	224 (1.3)		5,269 (29.6)	
Psychological risk factors			0.000		0.000
No	26,399 (96.5)	202 (0.8)		5,865 (22.2)	
Yes	968 (3.5)	48 (5.0)		532 (55.0)	

[a]χ^2 test.

vs. 23.4%). There was no difference in the prevalence of musculoskeletal pain for men in the LWC group, but women in the high LWC group reported lower musculoskeletal pain than those in the low LWC group (**Table 4**).

Table 5 presents the results of the multivariate logistic regression for occupational injury. All models confirmed a positive association between poor WLB and occupational injury. In the crude analysis (Model 1), a poor WLB was associated with an increased likelihood of occupational injury (OR: 1.75, 95% CI: 1.37–2.25). After adjusting for socio-demographic characteristics, including age and sex (Model 2), the OR increased slightly (OR: 1.78, 95% CI: 1.39–2.89). After adjusting for socio-demographic characteristics and key covariates (Model

Table 3. Relationship between WLB and occupational injury according to sex

Variables	Occupational injury					
	Male			Female		
	No. (%)	Yes (%)	*p*-value[a]	No. (%)	Yes (%)	*p*-value[a]
WLB			0.003			0.000
Good	7,899 (59.2)	83 (1.1)		8,475 (59.5)	33 (0.4)	
Poor	5,246 (40.8)	87 (1.7)		5,763 (40.5)	49 (0.9)	
WLB; quartile			0.000			0.000
Best (1st)	3,299 (25.1)	22 (0.7)		3,645 (25.6)	14 (0.4)	
Good (2nd)	4,600 (35.0)	61 (1.3)		4,830 (33.9)	19 (0.4)	
Poor (3rd)	2,120 (16.1)	35 (1.7)		2,263 (15.9)	13 (0.6)	
Worst (4th)	3,126 (23.8)	52 (1.7)		3,500 (24.6)	36 (1.0)	
WLC			0.000			0.000
Low	8,297 (62.4)	79 (1.2)		9,134 (64.2)	34 (0.4)	
High	4,848 (37.6)	91 (1.9)		5,104 (35.8)	48 (0.9)	
LWC			0.764			0.150
Low	8,828 (67.2)	116 (1.3)		9,239 (64.9)	47 (0.5)	
High	4,317 (32.8)	54 (1.3)		4,999 (35.1)	35 (0.7)	

WLB: work–life balance; WLC: work-on-life conflict; LWC: life-on-work conflict.
[a]χ^2 test.

Table 4. Relationship between WLB and work-related musculoskeletal pain according to sex

Variables	Work-related musculoskeletal pain					
	Male			Female		
	No. (%)	Yes (%)	*p*-value[a]	No. (%)	Yes (%)	*p*-value[a]
WLB			0.000			0.000
Good	7,899 (60.1)	1,477 (18.7)		8,475 (59.5)	1,997 (23.6)	
Poor	5,246 (39.9)	1,322 (25.2)		5,763 (40.5)	1,612 (28.0)	
WLB; quartile			0.000			0.000
Best (1st)	3,299 (25.1)	546 (16.6)		3,645 (25.6)	724 (19.9)	
Good (2nd)	4,600 (35.0)	931 (20.2)		4,830 (33.9)	1,273 (26.4)	
Poor (3rd)	2,120 (16.1)	555 (26.2)		2,263 (15.9)	727 (32.1)	
Worst (4th)	3,126 (23.8)	767 (24.5)		3,500 (24.6)	885 (25.3)	
WLC			0.000			0.000
Low	8,297 (63.1)	1,532 (18.5)		9,134 (64.2)	2,140 (23.4)	
High	4,848 (36.9)	1,267 (26.1)		5,104 (35.8)	1,469 (28.8)	
LWC			0.864			0.029
Low	8,828 (67.2)	1,876 (21.3)		9,239 (64.9)	2,396 (25.9)	
High	4,317 (32.8)	923 (21.4)		4,999 (35.1)	1,213 (24.3)	

WLB: work-life balance; WLC: work-on-life conflict; LWC: life-on-work conflict.
[a]χ^2 test.

3), the OR decreased slightly (OR: 1.67, 95% CI: 1.29–2.16). After further adjustment of ergonomic risk factors and psychological risk factors to model 3 (Model 4), the OR decreased (OR: 1.37, 95% CI: 1.06–1.78). Furthermore, Model 4 showed that the likelihood of injury increased in the blue-collar group compared to the white-collar group, as working hours increased (OR: 1.02, 95% CI: 1.01–1.03), with ergonomic risk factors (OR: 3.38, 95% CI: 2.23–5.12) and with psychological factors (OR: 6.07, 95% CI: 4.35–8.46). The likelihood of occupational injury decreased for female participants (OR: 0.46, 95% CI: 0.35–0.61) and for shift workers (OR: 0.64, 95% CI: 0.43–0.95).

Table 6 presents the results of the multivariate logistic regression for musculoskeletal pain. As with occupational injury, all models confirmed a positive association between poor WLB and musculoskeletal pain. In the crude analysis (Model 1), a poor WLB was associated with an increased likelihood of musculoskeletal pain (OR: 1.35, 95% CI: 1.28–1.43). After adjusting for socio-demographic characteristics including age and sex (Model 2), the OR increased slightly (OR: 1.41, 95% CI: 1.33–1.49). After adjusting for socio-demographic characteristics

Table 5. OR and 95% CIs for the association between WLB and occupational injury

Variables	Occupational injury			
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
Poor WLB (ref: good WLB)	1.75 (1.37–2.25)	1.78 (1.39–2.89)	1.67 (1.29–2.16)	1.37 (1.06–1.78)
Female (ref: male)		0.44 (0.34–0.57)	0.57 (0.43–0.76)	0.53 (0.40–0.71)
Age (years)		1.01 (1.00–1.02)	1.00 (0.99–1.01)	1.00 (0.99–1.01)
Occupation type				
Service workers (ref: white-collar)			1.34 (0.91–1.99)	1.30 (0.87–1.93)
Blue-collar (ref: white-collar)			2.90 (2.04–4.11)	2.30 (1.61–3.28)
Working hours per week			1.02 (1.01–1.03)	1.02 (1.01–1.03)
Part-time or temporary worker (ref: full-time worker)			1.33 (0.98–1.79)	1.25 (0.92–1.69)
Shift worker (ref: daytime worker)			0.64 (0.43–0.95)	0.64 (0.43–0.96)
Ergonomic risk factors (ref: non-exposure)				3.38 (2.23–5.12)
Psychological risk factors (ref: no)				6.07 (4.35–8.46)

OR: odds ratio; CI: confidence interval; WLB: work-life balance.
[a]Model 1: Crude; [b]Model 2: Adjusted for sex, age; [c]Model 3: Adjusted for Model 2 + occupation type, working hours, employment status, shift work; [d]Model 4: Adjusted for Model 3 + ergonomic and psychological risk factors.

Table 6. OR and 95% CIs for the association between WLB and work-related musculoskeletal pain

Variables	Work-related musculoskeletal pain			
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
Poor WLB (ref: good WLB)	1.35 (1.28–1.43)	1.41 (1.33–1.49)	1.30 (1.23–1.38)	1.14 (1.07–1.21)
Female (ref: male)		1.23 (1.16–1.30)	1.55 (1.45–1.65)	1.54 (1.44–1.64)
Age (years)		1.03 (1.03–1.03)	1.02 (1.02–1.02)	1.02 (1.02–1.02)
Occupation type				
Service workers (ref: white-collar)			1.51 (1.40–1.63)	1.44 (1.33–1.57)
Blue-collar (ref: white-collar)			2.78 (2.56–3.02)	2.30 (2.12–2.50)
Working hours per week			1.02 (1.02–1.02)	1.02 (1.02–1.02)
Part-time or temporary worker (ref: full-time worker)			1.13 (1.05–1.22)	1.09 (1.01–1.18)
Shift worker (ref: daytime worker)			1.03 (0.95–1.12)	1.05 (0.96–1.14)
Ergonomic risk factors (ref: non-exposure)				2.69 (2.50–2.89)
Psychological risk factors (ref: no)				4.32 (3.76–4.98)

OR: odds ratio; CI: confidence interval; WLB: work-life balance.
[a]Model 1: Crude; [b]Model 2: Adjusted for sex, age; [c]Model 3: Adjusted for Model 2 + occupation type, working hours, employment status, shift work; [d]Model 4: Adjusted for Model 3 + ergonomic and psychological risk factors.

and key covariates (Model 3), the OR decreased slightly (OR: 1.30, 95% CI: 1.22–1.37). After further adjustment of ergonomic risk factors and psychological risk factors to model 3 (Model 4), the OR decreased (OR: 1.14, 95% CI: 1.07–1.21). Furthermore, Model 4, showed that the likelihood of musculoskeletal pain increased for female participants (OR: 1.54, 95% CI: 1.44–1.64), as age increased (OR: 1.02, 95% CI: 1.02–1.02), in the service workers (OR: 1.44, 95% CI: 1.33–1.57) and blue-collar group (OR: 2.30, 95% CI: 2.12–2.50) compared to the white-collar group, as working hours increased (OR: 1.02, 95% CI: 1.02–1.02), for part-time or temporary workers (OR: 1.09, 95% CI: 1.01–1.18), with ergonomic risk factors (OR: 2.69, 95% CI: 2.50–2.89) and with psychological factors (OR: 4.32, 95% CI: 3.76–4.98).

DISCUSSION

This study showed that poor WLB is a significant risk factor for self-reported occupational injury and musculoskeletal pain among Korean workers. After controlling for socio-demographic characteristics and relevant key covariates, poor WLB increased the prevalence of occupational injury by 1.37 times and musculoskeletal pain by 1.14 times. This suggests that improvement of WLB might reduce the incidence of occupational injury and musculoskeletal pain among workers.

According to the 2017 Industrial Accidents Report published by the Korean Occupational Safety and Health Agency, the annual occupational injury rate was 0.48% [22]. In the present study, 252 out of 27,383 participants (0.9%) reported experiencing an occupational injury. However, given that we investigated the prevalence of occupational injury based on self-reported data, even minor injuries are likely to have been included; thus, the prevalence rate in the present study might differ from the official figure calculated based on worker's compensation results. Previous studies of occupational injury primarily investigated its relationship with psychosocial factors or occupational characteristics, such as working hours and shift work. A previous study reported that shift work increases the risk for occupational injury and that extended working hours are associated with an elevated risk for occupational injury in the USA [23]. In Korea, a 2013 study based on the First Korean Working Conditions Survey reported that workplace violence or increased job strain increases absenteeism resulting from occupational injury [24]. Further, a 2018 study conducted in a university hospital in Incheon reported that workers who are not satisfied with their lives are at a higher risk for occupational injury [25]. To the best of our knowledge, the present study is the first to report a significant association between WLB and occupational injury.

The mechanism by which poor WLB status affects occupational injury is unknown. Previous studies have shown that psychological factors, such as job stress and depression are associated with occupational injuries [26,27]. Moreover, WLB is associated with job stress and depression [13,28]. Therefore, it is suggested that WLB is related to psychological factors that affect occupational injuries.

Regarding WLB and musculoskeletal pain, a 2015 study based on the second Working Condition Survey data reported a significant association between the two parameters (OR: 1.68 for low back pain; OR: 1.80 for upper and lower limb muscle pain) [29]. Moreover, a 2017 study on South Korean workers reported that work–life imbalance and musculoskeletal symptoms are significantly associated (OR: 1.49 for men; OR: 1.50 for women). However, a limitation of the study was that it measured WLB using only one question: “How well do your working hours fit in with your family or social commitments? [30]” In the present study, WLB was assessed using 5 questions, which helped quantify WLB by dividing WLB status into quartiles. This also enabled a comparison of two dimensions of WLB: WLC and LWC. In this study, the OR of the poor WLB group for musculoskeletal symptoms was 1.3. Further, musculoskeletal pain among men and women in the poor and worst WLB groups was 1.8 times and 1.9 times higher, respectively, than the best WLB group. Moreover, for both men and women, WLC was more associated with musculoskeletal pain than was LWC.

Poor WLB has been identified as a risk factor for mental health in general and as a stressor or predictor of psychological distress [31]. Since psychological factors can cause musculoskeletal pain [32], there are several possible explanations for pathways linking psychosocial distress and musculoskeletal disorders. Psychosocial stress appears to trigger a chain of physiological reactions, including biochemical reactions, which may, in the short term, increase muscle tension and, in the long term, heighten the risk of musculoskeletal disorders [33]. Another explanation is that psychological stress has direct effects on mechanical load through changes in body posture [34].

In terms of WLC and LWC, a 2014 study on 6,091 workers at a university in Switzerland suggested that compared to LWC, WLC is more strongly associated with important organizational outcomes, such as turnover intention, job satisfaction, and organizational

commitment [35]. Another 2014 study of the factors influencing perception of WLB reported that WLC influenced perceptions of WLB, whereas LWC did not [36]. Our findings also showed that occupational injury and musculoskeletal pain increased with high WLC in both men and women. However, there was no significant relationship between LWC and injury for both men and women, but musculoskeletal pain decreased with high LWC in women, although it was not associated with LWC in men. These results highlight the need to understand WLB in terms of WLC and LWC.

In addition to WLB, in this study, sex, occupation type, working hours, ergonomic, and psychological risk factors were associated with both occupational injury and musculoskeletal pain. Injury and musculoskeletal pain increased in the blue-collar group compared to the white-collar group, with increased weekly working hours, and with ergonomic and psychological risk factors. In terms of -gender, the prevalence of injury was lower among women and that of musculoskeletal pain was higher among women. These results are consistent with a previous study, which reported that men are 3.5 times more likely to incur an occupational injury [37]. Further, a study on production operators, agricultural workers, and workers involved in repetitive tasks reported that the prevalence of musculoskeletal pain was higher among women than among men [38-40].

Shift work is an important work-place risk factor that is known to cause various work-related health problems, and previous studies have also reported that the prevalence of occupational injury is higher among shift workers [23,41,42]. Although we found no significant difference in the prevalence of injury according to shift work, additional studies are needed to confirm this.

Ergonomic and psychological risk factors are known to be major causes of occupational injury and musculoskeletal pain [43-45]. We also found that the likelihood of injury and musculoskeletal pain increased with ergonomic and psychological risk factors. In logistic regression Model 4, that adjusted for ergonomic and psychological risk factors in addition to relevant key covariates, the odds ratio of WLB for occupational injury was 1.37, and that for musculoskeletal pain was 1.14. These results highlight the significance of WLB for injury and musculoskeletal pain.

The most important and common health problems among workers are occupational injury and musculoskeletal pain. In contrast to studies that focus on a single health problem, we concurrently analyzed both in our study, targeting one study population. We found that WLB is associated with these two key work-related health problems in the same participants. In addition, while previous studies assessed WLB using a single question, we used five questions, which enabled us to classify WLB more accurately, in a more diverse target group. Moreover, this study targeted a large population of 27,383 individuals, generating a representative sample of the national population from across Korea.

This study has number of limitations. First, due to the nature of a cross-sectional design, we cannot determine the causal relationship of WLB with work-related health problems. As previously discussed, health problems are related to numerous factors in addition to psychosocial factors; thus, prospective studies are needed to shed further light on these factors. Second, this study utilized the self-reported responses from the Fifth KWCS, and therefore, the responses are subjective. In addition, we cannot ensure the independence of the questions themselves.

CONCLUSION

This study investigated the association of WLB with occupational injury and musculoskeletal pain among Korean workers. Our findings indicate that poor WLB is associated with occupational injury and musculoskeletal pain. Social and policy-related efforts are needed to improve workers' WLB to reduce occupational injury and musculoskeletal pain. Although a law pertinent to WLB was enacted in Korea in 2007 [46], compliance with the law is still low due to insufficient awareness and conflicting opinions among stakeholders. In addition, research into WLB is still limited in Korea compared to Europe and the USA. Nevertheless, we believe that our study highlights the significance of WLB and provides the basis for enacting change to improve WLB, thereby preventing occupational injury and musculoskeletal pain.

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