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Original Article

Work Sectors with High Risk for Work-Related Musculoskeletal Disorders in Korean Men and Women

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ABSTRACT

Background: To identify work sectors with high risk for work-related musculoskeletal disorders (MSDs) in Korean men and women.
Methods: We analyzed nationwide data to identify ergonomic risk factors in Korean employees. In particular, we analyzed data on exposure to five ergonomic risk factors (painful/tiring postures, lifting/moving heavy materials, standing/walking, repetitive hand/arm movements, and hand/arm vibration) according to employment sector, sex, and age, using the 2014 Fourth Korean Working Conditions Survey. We also used workers' compensation data on work-related MSDs in 2010, which is available by sex.
Results: The different work sectors had different gender distributions. "Manufacturing" (27.7%) and "construction" (11.3%) were dominated by males, whereas "human health and social work activities" (12.4%), "hotel and restaurants" (11.7%), and "education" (10.4%) were dominated by females. However, "wholesale and retail trade" and "public administration and defense" employed large numbers of males and females. Furthermore, the work sectors with a greater proportion of work-related MSDs and with multiple ergonomic risk factors were different for men and women. For men, "construction" and "manufacturing" had the highest risk for work-related MSDs; for women, "hotel and restaurants" had the highest risk for work-related MSDs.
Conclusion: Ergonomic interventions for workers should consider gender and should focus on work sectors with high risk for MSDs, with multiple ergonomic risk factors, and with the largest number of workers.

1. Introduction

The European Risk Observatory Report [1] classified musculoskeletal disorder (MSD) as the most prevalent occupational medical condition in Europe. Likewise, MSD is the most common occupational disease in Korea. MSDs have also increased over time in Korea [2]. In addition to their effects on workers themselves, work-related MSDs also increase costs to businesses and society. In order to reduce work-related MSD cases, Korean regulations state that that an employer of workplaces with even a single ergonomic hazard (musculoskeletal burden) among 11 hazards should assess the risk of the hazard(s) once every 3 years since 2003, by notification of Ministry of Employment and Labor. However, this approach may not be cost-effective.

Most workers are exposed to many ergonomic risk factors, especially those employed in construction, agriculture, manufacturing, wholesale and retail trade, and human health and social work [3]. Furthermore, work-related MSDs are more likely to be caused by complex ergonomic hazards. Hence, a national strategy for prevention of work-related MSDs should focus on high-risk work sectors, rather than individual workplaces. A strategy that focuses on high-risk work sectors can more efficiently and effectively prevent work-related MSDs. Thus, we must first identify the number and gender of workers in different work sectors, the gender-specific prevalence of different ergonomic risk factors, and gender-specific work-related MSDs in these different work sectors. This information will allow implementation of gender-specific interventions in high-risk work sectors.

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Our hypothesis is that work-related MSDs are more likely in work sectors that have complex ergonomic hazards and employ large numbers of workers, and that work-related MSDs differ for males and females. Thus, the purpose of this study is to determine the gender distributions, gender-specific exposure to ergonomic risks, and gender-specific work-related MSDs in different work sectors, and identify work sectors that have high risk for work-related MSDs in Korean men and women.

2. Methods

2.1. Data source

We performed a secondary analysis of data from the fourth Korean Working Conditions Survey, conducted in 2014 by the Korea Occupational Safety and Health Agency. In Korea, the legal work age is 15 years-old, so the study population was a representative sample of the economically active population who were aged 15 years or older.

Survey participants were included if they worked for pay or profit for at least 1 hour in the week preceding the interview. Thus, individuals who were retired, unemployed, homemakers, and students were excluded. A total of 50,007 face-to-face interviews were conducted. These individuals were classified as employees (30,751), self-employed (16,039), or employers (3,217). We analyzed the data of all 30,751 employees.

The basic study design was a multistage random sampling of the enumeration districts used in the 2010 population and housing census. Survey weighting was conducted with reference to the economically active population. In other words, distributions by region, locality, and its size, sex, age, economic activity, and occupation were identical to those of the overall active working population at the time of the survey.

The questionnaire contained items on working hours, physical risk factors, work organization, impact of work on health, satisfaction with working conditions, experience of violence, bullying, or harassment in the workplace, and other issues. The present study focused on exposure to ergonomic risk factors. The methodology and questionnaire were almost identical to those employed in the European Working Conditions Survey [4]. The quality of the Korean Working Conditions Survey was assured by its high external and content validity and reliability. The rigorous procedure used to develop the questionnaire contributed to its quality assurance. The high level of reliability was also guaranteed by the sophisticated field survey procedures and the development of a technical manual for interviewers [5].

We used workers' compensation data on work-related MSDs in 2010, which is available by sex [6].

2.2. Measurements

We used the data of exposure to five ergonomic risk factors—painful/tiring postures, lifting/moving heavy materials, standing/walking, repetitive hand/arm movements, and vibration due to a machine— by work sector and gender using data from the 2014 Fourth Korean Working Conditions Survey. All variables were measured using the same 7 point scale, and ranged from all the time (1) to never (7). Exposures to ergonomic risk factors were determined by asking: "Please tell me, using the scale (all of the time/almost all of the time/about three-quarters of the time/about half of the time/about one-quarter of the time/almost never/never), are you exposed at work to each of the following risk factors: painful or tiring postures, repetitive hand or arm movements, lifting heavy loads, standing posture, and vibration due to a machine?" Each risk factor was classified as "non-exposure" (less than 25% of working hours) or "exposure" (25% or more of working hours).

2.3. Data analysis

We performed a descriptive analysis to identify work sectors with high risk for work-related MSDs. The gender distribution of employees in different work sectors was determined using the Korean Standard Industrial Classification (KSIC). The rate of reporting exposure to ergonomic risk factors during at least 25% of working hours was calculated for males and females using the KSIC. Recognized work-related MSDs were determined for males and females using the KSIC.

3. Results

3.1. Gender distribution in different work sectors

Table 1 shows the percentage of males and females in different work sectors. There were 4,353 male workers in "manufacturing", and this accounted for 27.7% of all male workers. In addition, 11.5% of men were in "wholesale and retail trade", 11.3% were in "construction", and 6.9% were in "public administration and defense". A total of 17.5% of females were in "wholesale and retail trade", 13.4% were in "manufacturing", 12.4% were in "human health and social work activities", 11.7% were in "hotel and restaurants", and 10.4% were in "education". We classified each work sector as male-dominated (M), female-dominated (F), or mixed (M/F).

3.2. Gender-specific exposure to ergonomic risks in different work sectors

Table 2 shows the percentages of males and females reporting exposure to each ergonomic risk factor during at least one-quarter

Table 1
Gender distribution in different work sectors in 2014 [N(%)]

KSIC	Men	Women
Agriculture, forestry, & fishing (F)	100 (0.6)	200 (1.3)
Mining & quarrying (M)	11 (0.1)	0 (0.0)
Manufacturing (M)	4,353 (27.7)	2,017 (13.4)
Electricity, gas, steam, & water supply (M)	114 (0.7)	16 (0.1)
Sewerage, waste management, materials recovery, & remediation activities (M)	52 (0.3)	15 (0.1)
Construction (M)	1,787 (11.3)	340 (2.3)
Wholesale & retail trade (M/F)	1,811 (11.5)	2,629 (17.5)
Transportation (M)	864 (5.5)	189 (1.3)
Hotel & restaurants (F)	673 (4.3)	1,762 (11.7)
Information & communications (M)	408 (2.6)	216 (1.4)
Financial & insurance activities (F)	552 (3.5)	995 (6.6)
Real estate activities & renting & leasing (M)	531 (3.4)	309 (2.1)
Professional, scientific, & technical activities (M/F)	495 (3.1)	339 (2.3)
Business facilities management & business (M/F)	921 (5.9)	798 (5.3)
Public administration & defense (M/F)	1,086 (6.9)	793 (5.3)
Education (F)	822 (5.2)	1,558 (10.4)
Human health & social work activities (F)	370 (2.4)	1,860 (12.4)
Arts, sports, & recreation related services (M/F)	185 (1.2)	150 (1.0)
Repair & other personal services (M/F)	586 (3.7)	627 (4.2)
Activities of households as employers (F)	17 (0.1)	194 (1.3)
Activities of extraterritorial organizations & bodies (M)	4 (0.0)	2 (0.0)
Total	15,742 (100.0)	15,009 (100.0)

F, female; KSIC, Korean Standard Industrial Classification; M, male.

Table 2
Gender-specific exposure to ergonomic risks in different work sectors in 2014 (rate per 100)

KSIC	Ergonomic risk factors									
	Painful/tiring postures		Carrying/moving heavy loads		Standing/walking		Repetitive hand/arm movements		Hand/arm vibration	
	M	F	M	F	M	F	M	F	M	F
Agriculture, forestry, & Fishing (F)	71.0	84.5	67.0	62.0	80.0	62.5	83.0	91.5	46	22.5
Mining & quarrying (M)	90.9	0.0	36.4	0.0	54.5	0.0	72.7	0.0	81.8	0.0
Manufacturing (M)	53.5	54.2	43.3	32.0	57.4	43.4	69.3	76.2	53.5	38.4
Electricity, gas, steam, & water supply	38.6	43.8	21.1	25.0	50.9	62.5	52.6	68.8	36.0	12.5
Sewerage, waste management, materials recovery, & remediation activities (M)	55.8	20.0	65.4	6.7	69.2	20.0	80.8	26.7	69.2	20.0
Construction (M)	70.2	36.2	65.1	22.1	73.7	28.5	74.9	53.8	63.7	19.7
Wholesale & retail trade (F)	42.2	51.5	45.4	43.2	66.6	71.8	58.5	64.9	14.1	7.6
Transportation	62.8	44.4	38.4	30.2	37.0	33.3	71.2	68.3	41.6	16.9
Hotel & restaurants (M/F)	56.2	71.4	57.2	61.8	85.1	91.3	75.6	82.8	20.2	15.9
Information & communications	41.7	41.2	18.6	14.8	26.5	23.6	55.9	58.8	11.8	6.5
Financial & insurance activities	28.1	31.7	5.8	7.9	31.0	34.6	50.2	46.3	2.2	2.7
Real estate activities & renting & leasing	39.5	42.4	37.5	21.7	54.8	47.6	45.6	57.9	14.1	7.1
Professional, scientific, & technical activities	35.8	34.5	16.6	9.7	31.9	23.0	53.7	62.8	13.3	6.2
Business facilities management & business (M/F)	55.5	64.9	55.2	40.5	68.3	61.3	60.7	76.6	34.4	11.9
Public administration & defense	44.4	45.9	23.8	18.5	48.6	50.2	58.7	67.1	15.3	7.9
Education	36.9	43.0	7.7	15.1	68.6	73.2	60.0	66.2	5.5	5.4
Human health & social work activities (F)	41.4	52.6	23.0	27.2	54.6	72.2	58.4	66.8	18.4	9.6
Arts, sports, & recreation related services	42.7	40.7	29.7	21.3	64.9	56.7	64.3	62.7	21.6	11.3
Repair & other personal services (M/F)	56.8	62.2	48.0	26.2	67.2	67.9	65.5	74.2	46.4	20.7
Activities of households as employers (F)	47.1	59.8	11.8	26.8	64.7	61.9	70.6	63.9	0.0	1.5
Activities of extraterritorial organizations & bodies	0.0	50.0	25.0	0.0	0.0	0.0	50.0	50.0	0.0	0.0
Total	50.8	52.2	40.4	32.0	58.9	61.9	64.6	68.6	34.7	13.7

F, female; M, male.
*We included respondents who reported exposure to each occupational risk factor at least 1/4 of working time.

of the work time for the different work sectors. Among work sectors with the greatest number of male workers ("manufacturing", "wholesale and retail trade", "construction", and "public administration and defense"), more than 50% of the respondents employed in "manufacturing" and "construction" reported exposure to more than three ergonomic risk factors. Among the work sectors with the greatest number of female workers ("wholesale and retail trade" "manufacturing", "human health and social work activities", "hotel and restaurants", and "education"), more than 50% of the respondents employed in "hotel and restaurants" reported exposure to more than three ergonomic risk factors.

3.3. Gender and work sector-related MSDs

Table 3 shows the numbers and percentages of compensated work-related MSDs for males and females in different work sectors during 2010. For males, work-related MSDs were most prevalent in "construction", "manufacturing", "hotel and restaurants", "agriculture and forestry", and "wholesale and retail trade" (in descending order). For females, work-related MSDs were most prevalent in "hotel and restaurants", "wholesale and retail trade", "agriculture and forestry", "construction", and "activities of households as employers" (in descending order). Considering Tables 1 and 2 together, our data for males indicate that "construction" and "manufacturing" had the largest number of workers, the greatest number of ergonomic risk factors, and the most work-related MSDs. However, our data for females indicate that "hotel and restaurants" had the largest number of workers, the greatest ergonomic risk factors, and the most work-related MSDs.

Table 3
Compensated work-related musculoskeletal disorders cases by gender and work sector in 2010

KSIC (dominant sex)	N (%)	
	Male	Female
Agriculture & forestry (F)	594 (6.5)	140 (3.7)
Fishing (M)	23 (0.3)	2 (0.1)
Mining & quarrying (M)	62 (0.7)	—
Manufacturing (M)	1,256 (13.7)	88 (2.3)
Electricity, gas, steam, & water supply (M)	57 (0.6)	8 (0.2)
Construction (M)	4,992 (54.4)	133 (3.5)
Wholesale & retail trade (M/F)	351 (3.8)	156 (4.2)
Transportation (M)	51 (0.6)	2 (0.1)
Hotel & restaurants (F)	948 (10.3)	2,904 (77.2)
Information & communications (M)	321 (3.5)	5 (0.1)
Financial & insurance activities (F)	61 (0.7)	25 (0.7)
Real estate activities & renting & leasing (M)	28 (0.3)	3 (0.1)
Business facilities management & business (M/F)	159 (1.7)	48 (1.3)
Public administration & defense (M/F)	67 (0.7)	12 (0.3)
Education (F)	6 (0.0)	14 (0.4)
Human health & social work activities (F)	46 (0.5)	62 (1.6)
Arts, sports, & recreation related services (M/F)	46 (0.5)	11 (0.3)
Repair & other personal services (M/F)	53 (0.6)	19 (0.5)
Activities of households as employers (F)	43 (0.5)	124 (3.3)
Activities of extraterritorial organizations & bodies (M)	8 (0.1)	4 (0.1)
Total	9,172 (100.0)	3,760 (100.0)

F, female; KSIC, Korean Standard Industrial Classification; M, male.

4. Discussion

Workers are generally exposed to several ergonomic risk factors at the same time, so the mono-causality principle prevents making correct assessments of risk factors at work [1]. Assessment of the "strenuousness at work" could help develop a new paradigm behind policies that consider the multifactorial causality of MSDs [1]. Choi [7] reported that simultaneous exposure to "repetitive work", "awkward-posture", and "heavy load" explains 38% of MSDs in the "transportation machinery and equipment manufacturing" sector. The present study also showed that workers in several work sectors reported exposure to complex ergonomic risk factors that could lead to work-related MSDs.

Our results showed that there are different gender distributions in different work sectors. More specifically, "manufacturing" (27.7%) and "construction" (11.3%) were dominated by males, whereas "human health and social work activities" (12.4%), "hotel and restaurants" (11.7%), and "education" (10.4%) were dominated by females. "Wholesale and retail trade" and "public administration and defense" employed large numbers of males and females. Furthermore, the work sectors with complex ergonomic risk factors and more work-related MSDs differed for men and women. For men, "construction" and "manufacturing" had the greatest risk for work-related MSDs; for women, "hotel and restaurants" had the greatest risk for work-related MSDs. Taken together, men and women dominated different work sectors and these differences may be responsible for the gender differences in exposure to ergonomic risk factors and the differences in high-risk work sectors for work-related MSDs.

The present findings are comparable to those of previous studies. Differences in the health status of male and female workers could be caused by differences in exposure to different risk factors. Because of gender segregation of the labor market, men and women often have different jobs, and are therefore exposed to different risks. Furthermore, even when men and women have the same job, they may have different specific tasks that could cause differences in exposure to risks [8–13]. This may explain why work-related MSDs differ for males and females [14]. Previous studies [15–17] showed that sex differences in work-related MSDs are caused by differences in the percentage of males and females in each sector. Coury et al. [18] reported no difference in work-related MSDs for men and women if they were the same age and performed the same tasks for the same period. Taken together, this previous research and our results suggest that prevention of work-related MSDs should consider gender, regardless of the reason for the gender differences. Therefore, governmental agencies for occupational health and safety should compile statistics on the number of workers and cases of workers' compensation for men and women in different work sectors, and should establish strategies for prevention of occupational health problems based on the gender distribution of different work sectors and gender differences in exposure to occupational hazards.

The present study is the first to identify work sectors with high risk for MSDs in Korean men and women, to the best of our knowledge. Men in "construction" and "manufacturing" have high risk for work-related MSDs, and women in "hotel and restaurants" have high risk for work-related MSDs. Thus, measures to prevent work-related MSDs should target these high-risk work sectors. Our study has several public health implications. First, gender-specific statistics on occupational health and safety should be compiled. Second, gender and work sector-specific strategies are needed to prevent work-related MSDs. The Korean government should focus on high-risk work sectors and disseminate gender-specific measures for prevention of work-related MSDs. Our study has several important strengths. In particular, we examined a large and representative sample of the Korean working population and used rigorous quality control of study procedures. The present study also had several limitations. We used subjective self-reported data, instead of objective findings, and relied upon workers' compensation data from 2010, because the data for 2014 were not available by sex.

In conclusion, our results show that men working in "construction" and "manufacturing" have high risk for work-related MSDs, and women working in "hotel and restaurants" and "wholesale and retail trade" have high risk for work-related MSDs. Based on the results presented here, the Korean government should develop and disseminate gender- and work-sector specific manuals to prevent work-related MSDs.

Conflicts of interest

The authors declare they have no conflicts of interest.

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