applied sciences

MDPI

Article

Exposure Time to Work-Related Hazards and Factors Affecting Musculoskeletal Pain in Nurses

Woo Jin Kim [1,2] and Byung Yong Jeong [2,*]

[1] Environmental Hygiene Team, Incheon Area Office, Korean Industrial Health Association, Incheon 22146, Republic of Korea; wj.kim@kiha21.or.kr
[2] Department of Industrial and Management Engineering, Hansung University, Seoul 02876, Republic of Korea
* Correspondence: byjeong@hansung.ac.kr

Abstract: Nurses who work in hospitals are exposed to various occupational hazards and are recognized as having high rates of musculoskeletal pain. This study aims to estimate the level of exposure to work-related hazards for nurses working in hospitals and derive factors that affect back pain, upper limb pain, and lower limb pain. This study was conducted on 462 nurses from the 6th Korean Working Condition Survey (KWCS) data, deriving exposure time related to physical, biochemical, and ergonomic hazards. Also, using binomial logistic regression analysis, this study determines the factors influencing musculoskeletal pain by comprehensively considering work-related factors and physical, biochemical, and ergonomic hazards. The exposure time for standing is the highest, followed by repetitive movements, awkward postures, patient lifting/carrying, infection, heavy object handling, and vibration. The average exposure times to occupational hazards were higher for nurses experiencing pain in their back, upper limbs, and lower limbs than those without pain complaints. Factors that contribute to back pain include years of work experience ($p = 0.002$), type of healthcare establishment ($p = 0.001$), exposure level to vibration ($p = 0.029$), and awkward posture level ($p < 0.001$). Factors affecting upper limb pain include the type of shift work ($p = 0.013$), handling heavy objects ($p < 0.001$), awkward postures ($p = 0.033$), and repetitive movements ($p = 0.002$). The factors that influence lower limb pain are awkward posture ($p = 0.001$), patient lifting/carrying ($p = 0.002$), and repetitive movements ($p = 0.006$). This study emphasizes the importance of implementing strategies to improve occupational hazards to prevent or alleviate musculoskeletal pain. These findings provide practical guidance for managing risk factors and preventing musculoskeletal disorders among nursing professionals.

Keywords: musculoskeletal disorders; occupational hazards; back pain; upper limb pain; lower limb pain

Citation: Kim, W.J.; Jeong, B.Y. Exposure Time to Work-Related Hazards and Factors Affecting Musculoskeletal Pain in Nurses. *Appl. Sci.* **2024**, *14*, 2468. https://doi.org/10.3390/app14062468

Academic Editor: Nicola Magnavita

Received: 15 February 2024
Revised: 9 March 2024
Accepted: 13 March 2024
Published: 14 March 2024

1. Introduction

1.1. Purpose of Study

The healthcare industry is labor-intensive, primarily focusing on diagnosing, treating, and managing patients [1]. A nurse is a healthcare professional who is legally qualified to monitor and record the patient's health status and provide prescribed care and treatment based on a doctor's orders or specific nursing procedures [2]. Nursing services are essential in the healthcare sector, and with the aging population, there is an increasing need for nursing services in nursing homes and residential facilities [3].

Protecting healthcare workers' health and safety improves productivity, job satisfaction, and retention [4,5]. Nurses who have direct contact with patients are exposed to various types of potential hazards. Assessing occupational risks for nurses helps prioritize control measures. However, limited research has been conducted to analyze the extent of workers' exposure to various risk factors, including biochemical, physical, and ergonomic hazards in specific occupations [6,7]. This study aims to investigate the level of exposure of nursing professionals to various risk factors.

While ergonomic risk factors present the closest association with musculoskeletal pain [1,3,4,8], there is evidence that exposure to physical and chemical/biological hazards is also related to pain [8]. There is a lack of research analyzing the priority and impact of various risk factors on musculoskeletal pain, taking into consideration nurses' job-related characteristics, as well as the duration of exposure to these risk factors. This study aims to investigate whether nurses are exposed to physical, biochemical, and ergonomic hazards and to systematically analyze the priority and degree of impact of these risk factors on musculoskeletal pain, taking into account workers' characteristics and the exposure time to these risk factors among workers with back pain, upper limb pain, and lower limb pain.

1.2. Theoretical Background

1.2.1. Occupational Hazards in Nurses

Nurses are exposed to biological risks such as infection from viruses, blood, and bodily fluids, as well as chemical hazards like disinfectants, sterilizing agents, drugs, and anesthetics that can cause skin and respiratory issues [8]. Healthcare workers are exposed to physical risks such as noise and vibration [1,8]. Nurses commonly face various ergonomic risk factors in their work, such as lifting patients, using machines to move objects, repetitive actions, extreme postures, bending, twisting, and sudden movements [4,8–10]. These ergonomic risk factors are known to contribute significantly to musculoskeletal pain [1,3,8].

1.2.2. Nurses and Musculoskeletal Pain

Despite technological advances, healthcare workers are recognized as one of the professions with the highest prevalence of musculoskeletal disorders [11]. The musculoskeletal pain experienced by nurses is influenced by worker-related characteristics such as age, gender, years of service [4,12,13], ward, hospital size, workload [8,10,14,15], and shift work [16]. Research shows that women are more susceptible to musculoskeletal pain than men [14,17]. Musculoskeletal disorders in nurses are common in the back and upper extremities, including shoulders, elbows, and hands, although reports also indicate a high prevalence in the lower extremities, such as the knees and ankles [18].

2. Methods

2.1. Objective and Contents of Analysis

First, this study estimates the exposure time to hazards per day and conducts a mean test to determine whether there is a difference between the average exposure time of each hazard for nurses who report musculoskeletal pain and those who do not. Second, this study aims to identify factors affecting musculoskeletal pain in nurses using binary logistic regression. The analysis was conducted using the statistical package SPSS 18.0, with a significance level of 0.05.

2.2. Data Collection and Subjects

This study analyzed data from the 6th Korean Working Conditions Survey (KWCS) conducted by the Occupational Safety and Health Research Institute (OSHRI). The KWCS questionnaire [19] was designed to be similar to the European Working Conditions Survey (EWCS) questionnaire [20].

The raw data from the 6th Korean Working Conditions Survey, conducted in 2020, were compiled from responses from 50,538 participants [19]. The total data were extracted from respondents whose occupations were nurses and nursing assistants, and those working in hospitals and clinics were included as subjects. The data correspond to the occupational classifications of registered nurses and nurse aides based on the Korean Standard Occupational Classification [21]. Among these subjects, participants who did not answer questions about study variables were excluded. After excluding male nurses who accounted for less than 3% of the total subjects, a total of 462 female nurses were selected as research subjects. These 462 female nurses were distributed across different types of institutions, with 230 (49.8%) working in hospitals and 232 (50.2%) in clinics. Regarding job roles, 277 (60.0%)

were registered nurses, and 185 (40.0%) were nurse aides. Out of the 462 people, 68 (14.7%) were in their 20s, 146 (31.6%) were in their 30s, 151 (32.7%) were in their 40s, and 97 (21.0%) were 50 years old or above.

2.3. Research Variables

The study's variables consisted of inquiries regarding worker characteristics, hazard factors, and musculoskeletal pain from the KWCS questionnaire.

Worker characteristics were defined by the respondents' job positions (registered nurse, nurse aide), age groups (less than 40, 40s, 50 or older), years of service (less than 3 years, 3–6 years, 6 or more years), type of healthcare institution (clinic, hospital), weekly working hours (less than 41 h, 41 h or more), and shift work patterns (day shift, daily divided shift, fixed shift, rotating shift).

Hazard factors included physical hazards (vibration, noise, high temperature, low temperature), biological and chemical (biochemical) hazards (fumes and dust, vapors, skin contact with chemicals, tobacco smoke, infection), and ergonomic hazards (awkward postures, heavy object handling, patient lifting/carrying, standing posture, sitting posture, repetitive motion). The KWCS survey evaluated the levels of exposure to different hazard factors by assigning scores based on the frequency of exposure. The questionnaire about hazard factors was "Are you exposed at work to each hazard? Please tell me using the following scale". The scores ranged from 1 to 7 ("1: Never, 2: Almost never, 3: 1/4 time, 4: 1/2 time, 5: 3/4 time, 6: Most of the time, 7: Always").

The variable to measure musculoskeletal pain included pain in the back, lower limbs, or upper limbs. The questionnaire asked, "Have you experienced any pain in your back, lower limbs, or upper limbs due to work in the past year?" with the answer options being "yes" or "no". Upper limb pain refers to pain in the shoulder, neck, elbow, wrist, and hand, while lower limb pain is in the hips, legs, knees, and feet.

2.4. Estimation of Daily Exposure Times and Levels to Hazards

Since the daily working hours and working days may vary for different workers, the daily exposure time for each risk factor was estimated as (daily exposure time) = (weekly working hours/working days) X (exposure frequency score for the risk factor). Exposure frequency scores for each risk factor were converted to weighted scores through consultation with fellow researchers, with frequencies 5, 6, and 7 receiving a weight of 3/4, 4 weighted as a 1/2, 3 weighted as a 1/4, and 1 and 2 being assigned a weight of 0.1 [9,22]. Exposure levels were classified into three levels (less than 2 h, 2–4 h, and more than 4 h) according to OSHA's Caution Zone [23] and Hazard Zone [24] classification criteria.

2.5. Logistic Regression Analysis and Model Fit Test

This study conducts a binary logistic regression analysis to determine factors that affect nurses' musculoskeletal pain with back pain, upper limb pain, or lower limb pain as dependent variables. The independent variables in the regression analysis include age, occupation, work experience, working hours per week, type of healthcare establishment, shift system, exposure levels to physical hazards (vibration, noise, high temperature, low temperature), exposure levels to biochemical hazards (fumes and dust, vapors, skin contact with chemicals, tobacco smoke, infection), and exposure levels to ergonomic hazards (awkward postures, heavy object handling, patient lifting/carrying, standing posture, sitting posture, repetitive motion).

The explanatory power of the binary logistic regression model for musculoskeletal pain was assessed using the Nagelkerke value. Model fit was evaluated using the Hosmer–Lemeshow test's χ^2 and significance value. Prediction accuracy was expressed as a percentage. The analysis was conducted using the backward Wald entry method.

2.6. Reliability Analysis

Table 1 presents the results of the reliability analysis for survey items related to physical, biochemical, and ergonomic hazards among independent variables. Cronbach's α value was used to analyze the internal consistency of these variables, and the 'sitting posture' item among ergonomic hazards was removed.

Table 1. Results of reliability analysis for hazard factors.

Hazard Factors	Initial Items	Removed Item	Final Items	Cronbach's Alpha
Physical hazards	4	0	4	0.831
Chemical hazards	5	0	5	0.706
Ergonomic hazards	6	Sitting posture	5	0.627

3. Results

3.1. Hazard Exposure Time

Table 2 displays the distribution of respondents' exposure levels to physical, biochemical, and ergonomic hazards, along with the average exposure time. In Table 2, the exposure time for standing posture is the highest, with an average of 4.276 h, followed by repetitive movements (3.031 h), awkward postures (2.163 h), patient lifting/carrying (1.352 h), infection exposure (1.230 h), heavy object handling (1.124 h), and vibration (0.947 h). Overall, exposure times to ergonomic hazards are significantly higher than those of biochemical and physical hazards.

Table 2. Distribution and mean and standard deviation (SD) of hazard exposure time.

Factor	Hazard	Exposure Time		Exposure Time Distribution			Ratio
		Mean	SD	<2 h	2–4 h	>4 h	>2 h
Physical hazards	Vibration	0.947	0.699	93.9%	3.9%	2.2%	6.1%
	Noise	0.894	0.564	95.5%	3.2%	1.3%	4.5%
	High temperature	0.840	0.391	98.5%	0.6%	0.9%	1.5%
	Low temperature	0.823	0.331	99.4%		0.6%	0.6%
	Fumes/dust	0.800	0.093	100.0%			0.0%
Biological hazards	Vapor	0.808	0.180	99.6%	0.2%	0.2%	0.4%
	Chemical contact	0.911	0.665	96.3%	2.2%	1.5%	3.7%
	Tobacco smoke	0.812	0.259	99.8%		0.2%	0.2%
	Infection	1.230	1.287	87.4%	5.8%	6.7%	12.6%
Ergonomic hazards	Awkward posture	2.163	1.961	60.6%	13.6%	25.8%	39.4%
	Patient lifting	1.352	1.150	73.2%	20.6%	6.3%	26.8%
	Load handling	1.124	0.963	85.3%	10.4%	4.3%	14.7%
	Standing posture	4.276	1.900	12.8%	19.5%	67.7%	87.2%
	Repetitive motion	3.031	2.321	45.9%	10.6%	43.5%	54.1%

According to Table 2, the highest ratio of exposure time for more than 2 h was for standing posture at 87.2%, followed by repetitive motion at 54.1%, awkward postures at 39.4%, patient lifting/carrying at 26.8%, and heavy object handling at 26.8%. On the other hand, among biochemical hazards, the proportion of nurses who complained of exposure for more than 2 h was 12.6% for infection and 3.7% for contact with chemicals, and for physical hazards, 6.1% for vibration, 4.5% for noise, and 1.5% for high temperature.

3.2. Musculoskeletal Pains and Exposure Times to Hazards

3.2.1. Comparison of Exposure Time to Hazards by Back Pain

Table 3 shows the mean comparison test results for exposure times of physical, chemical, or ergonomic hazards between nurses with and without back pain complaints.

Table 3. Results of mean comparison test for exposure times of hazards between nurses with and without back pain complaints.

Factor	Hazard	No Pain		Back Pain		*p*-Value
		Mean	SD	Mean	SD	
Physical hazard	Vibration	0.9078	0.6142	1.0758	0.9141	0.028 *
	Noise	0.8470	0.3782	1.0472	0.9289	0.001 *
	High temperature	0.8175	0.2613	0.9108	0.6499	0.029 *
	Low temperature	0.8050	0.1880	0.8829	0.5900	0.032 *
Biological hazard	Fumes/dust	0.7959	0.0792	0.8150	0.1281	0.062
	Vapor	0.7993	0.1019	0.8352	0.3215	0.069
	Chemical contact	0.8997	0.6271	0.9472	0.7790	0.516
	Tobacco smoke	0.7988	0.0916	0.8536	0.5072	0.054
	Infection	1.1628	1.1929	1.4455	1.5396	0.045 *
Ergonomic hazard	Awkward posture	1.8537	1.6819	3.1650	2.4229	<0.001 *
	Patient lifting	1.2282	0.9596	1.7541	1.5579	<0.001 *
	Load handling	1.0098	0.7079	1.4948	1.4635	<0.001 *
	Standing posture	4.1645	1.8571	4.6368	2.0008	0.023 *
	Repetitive motion	2.8401	2.2422	3.6489	2.4711	0.001 *

* significant at 0.05, SD = standard deviation.

During mean comparison tests for exposure times, it was observed that there were significant differences in the exposure times for physical hazards such as vibration, noise, and high and low temperatures between nurses who reported back pain and those who did not. On average, nurses with back pain complaints had a higher exposure time to these physical hazards compared to those without any back pain complaints. In addition, it was found that there was a difference in the average between the groups of those complaining of back pain and those not complaining about ergonomic hazards. The average exposure time of those complaining of back pain in awkward postures, patient lifting/carrying, heavy object handling, standing posture, and repetitive motion was higher than in those without back pain. In the case of biochemical hazards, the only difference was in the average exposure time for infection, with nurses with back pain complaints having a higher average exposure time than those without complaints.

3.2.2. Comparison of Exposure Time to Hazards by Upper Limb Pain

Table 4 displays the results of the mean comparison test for exposure times of physical, chemical, or ergonomic hazards between nurses with and without complaints of upper limb pain.

In the case of physical hazards, the average exposure time to noise and low temperature was longer for nurses complaining of upper limb pain than for nurses not complaining. The average exposure time to ergonomic hazards such as awkward posture, patient lifting/carrying, handling heavy objects, and repetitive motion was longer for nurses who complained of upper limb pain than for nurses who did not complain of pain. Regarding biochemical hazards, only for smoke and dust did nurses complaining of upper extremity pain have a longer average exposure time than nurses without complaints.

3.2.3. Comparison of Exposure Time to Hazards by Lower Limb Pain

Table 5 presents the results of the mean test for exposure times of physical, chemical, or ergonomic hazards between nurses with and without complaints of lower limb pain.

Table 4. Results of mean comparison test for exposure times of hazards by upper limb pain.

Factor	Hazard	No Pain		Upper Limb Pain		*p*-Value
		Mean	SD	Mean	SD	
Physical hazard	Vibration	0.911	0.571	1.035	0.932	0.082
	Noise	0.845	0.389	1.010	0.837	0.004 *
	High temperature	0.817	0.273	0.893	0.580	0.058
	Low temperature	0.804	0.197	0.870	0.526	0.047 *
	Fumes/dust	0.794	0.084	0.816	0.111	0.017 *
Biological hazard	Vapor	0.807	0.208	0.809	0.084	0.919
	Chemical contact	0.892	0.585	0.955	0.826	0.355
	Tobacco smoke	0.810	0.301	0.816	0.111	0.800
	Infection	1.162	1.127	1.391	1.597	0.080
Ergonomic hazard	Awkward posture	1.893	1.758	2.805	2.255	<0.001 *
	Patient lifting	1.181	0.890	1.759	1.534	<0.001 *
	Load handling	0.963	0.661	1.506	1.375	<0.001 *
	Standing posture	4.210	1.872	4.433	1.963	0.249
	Repetitive motion	2.770	2.252	3.649	2.374	<0.001 *

* significant at 0.05, SD = standard deviation.

Table 5. Results of mean comparison test for exposure times of hazards by lower limb pain.

Factor	Hazard	No Pain		Upper Limb Pain		*p*-Value
		Mean	SD	Mean	SD	
Physical hazard	Vibration	0.915	0.649	1.105	0.894	0.028 *
	Noise	0.840	0.338	1.156	1.114	<0.001 *
	High temperature	0.818	0.260	0.943	0.747	0.010 *
	Low temperature	0.812	0.246	0.879	0.590	0.101
	Fumes/dust	0.795	0.083	0.826	0.130	0.008 *
Biological hazard	Vapor	0.807	0.193	0.813	0.089	0.767
	Chemical contact	0.891	0.615	1.008	0.867	0.153
	Tobacco smoke	0.811	0.282	0.813	0.089	0.953
	Infection	1.145	1.120	1.637	1.854	0.002 *
Ergonomic hazard	Awkward posture	1.923	1.750	3.325	2.465	<0.001 *
	Patient lifting/carrying	1.225	0.946	1.969	1.720	<0.001 *
	Heavy load handling	1.048	0.823	1.495	1.412	<0.001 *
	Standing posture	4.112	1.881	5.071	1.800	<0.001 *
	Repetitive motion	2.804	2.241	4.133	2.398	<0.001 *

* significant at 0.05, SD = standard deviation.

Regarding physical hazards, there were differences in the average exposure times for vibration, noise, and high temperature. Nurses with lower limb pain complaints had longer average exposure times for these physical risk factors compared to those without complaints. Nurses with lower limb pain complaints had higher average exposure times for ergonomic risk factors such as awkward postures, patient lifting/carrying, handling heavy objects, standing postures, and repetitive motion than those without complaints. In terms of biochemical hazards, nurses who complained of lower limb pain had higher average exposure times for fumes/dust and infection compared to those without complaints.

3.3. Factors Affecting Musculoskeletal Pains

3.3.1. Factors Affecting Back Pain

Table 6 provides back pain prevalence rates for different variable levels. The overall prevalence of back pain was 19.0%. The back pain prevalence rate was higher for nurses with over 6 years of work experience, those working in hospitals, and those exposed to more than 4 h of vibration or poor posture.

Table 6. Results of binary logistic regression analysis with back pain.

Variables	Prevalence Rate (%)	B	*p*-Value	OR	95% C.I. for OR	
					Lower	Upper
Occupation			0.067			
Nurses (ref)	19.1%					
Nursing assistants	18.9%	0.522	0.067	1.685	0.964	2.947
Working experience (Years)			0.002 *			
<3 (ref)	15.5%					
3–6	13.6%	−0.198	0.573	0.820	0.412	1.634
≥6	27.1%	0.809	0.010 *	2.245	1.218	4.136
Establishment type			0.001 *			
Clinics (ref)	13.4%					
Hospitals	24.8%	0.927	0.001 *	2.526	1.446	4.412
Vibration			0.029 *			
<2 h (ref)	19.1%					
2–4 h	5.6%	−1.956	0.070	0.141	0.017	1.174
≥4 h	40.0%	1.433	0.052	4.192	0.987	17.813
Awkward posture			<0.001 *			
<2 h (ref)	13.9%					
2–4 h	12.7%	−0.029	0.945	0.971	0.420	2.247
≥4 h	34.5%	1.245	<0.001 *	3.473	2.034	5.931
Constants		−2.852	<0.001 *	0.058		

* significant at 0.05, ref = reference, OR = odds ratio, C.I. = confidence interval.

Table 6 presents the results of a binary logistic regression analysis with back pain as the dependent variable. The analysis considered various independent variables, including age, occupation, work experience, working hours per week, establishment type, shift system, exposure levels to physical hazards (vibration, noise, high temperature, low temperature), exposure levels to biochemical hazards (dust and fumes, vapor, skin contact with chemicals, cigarette smoke, infection), and exposure levels to ergonomic hazards (awkward posture, handling heavy objects, patient lifting/carrying, standing posture, sitting posture, repetitive motion). The binary logistic regression model that investigated the factors affecting back pain showed good explanatory power with a Nagelkerke value of 0.171. The model's goodness of fit was deemed adequate, as per the Hosmer–Lemeshow test (χ^2 = 5.323, significance value = 0.723), and it was able to predict with an accuracy of 82.7%.

The factors significantly associated with back pain included years of work experience (p = 0.002), establishment type (p = 0.001), exposure level to vibration (p = 0.029), and exposure to awkward posture ($p < 0.001$). Nurses with more than 6 years of work experience were 2.239 times more likely to report back pain than those with less than 3 years of experience. Hospital workers had a 2.245 times higher likelihood of reporting back pain than those in clinics. Nurses exposed to awkward posture for more than 4 h were 3.473 times more likely to report back pain than those with less than 2 h.

3.3.2. Factors Affecting Upper Limb Pain

Table 7 displays the proportion of nurses experiencing pain in their upper limbs for different variable levels, and the overall prevalence of upper limb pain was 26.0%. Notably, upper limb pain prevalence rates were relatively higher for nurses with shifts and those exposed to specific hazards for more than 2 h, such as repetitive motion or handling heavy objects.

Table 7. Results of binary logistic regression analysis with upper limb pain.

Variables	Prevalence Rate (%)	B	*p*-Value	OR	95% C.I. for OR	
					Lower	Upper
Working experience (Years)			0.068			
<3 (ref)	26.1%					
3–6	20.1%	−0.013	0.967	0.987	0.539	1.809
≥6	31.3%	0.554	0.057	1.739	0.983	3.078
Shift system			0.013 *			
Day duty (ref)	21.3%					
Daily split shifts	60.0%	1.568	0.129	4.796	0.633	36.358
Permanent shifts	41.4%	1.055	0.002 *	2.872	1.460	5.650
Rotating shifts	31.0%	0.248	0.423	1.281	0.699	2.347
Heavy load handling			<0.001 *			
<2 h (ref)	21.1%					
2–4 h	47.9%	1.187	0.001 *	3.276	1.656	6.479
≥4 h	70.0%	1.977	<0.001 *	7.224	2.495	20.916
Standing posture			0.033 *			
<2 h (ref)	25.4%					
2–4 h	14.6%	−1.061	0.020 *	0.346	0.141	0.847
≥4 h	29.1%	−0.198	0.578	0.820	0.408	1.648
Repetitive motion			<0.001 *			
<2 h (ref)	17.0%					
2–4 h	40.8%	1.430	<0.001 *	4.181	2.001	8.733
≥4 h	31.8%	0.634	0.017 *	1.885	1.122	3.165
Constant		−2.072	<0.001 *	0.126		

* significant at 0.05, ref = reference, OR = odds ratio, C.I. = confidence interval.

The binary logistic regression model with upper limb pain showed good explanatory power (Nagelkerke value = 0.210). The Hosmer and Lemeshow test demonstrated a satisfactory level of goodness of fit for the model (χ^2 = 9.763, p = 0.282). Additionally, the model had a high prediction accuracy of 79.7%. In Table 7, factors significantly associated with upper limb pain included the type of shift work (p = 0.013), handling heavy objects (p < 0.001), awkward posture (p = 0.033), and repetitive motion (p = 0.002).

Permanent shift nurses are 2.872 times more likely to experience upper limb pain than day duty workers. In the case of manual handling of heavy objects, nurses exposed to it for 2–4 h have a 3.276 times higher likelihood of experiencing upper limb pain than those exposed for less than 2 h. Similarly, those exposed for 4 h or more have a 7.224 times higher likelihood. Repetitive motion is linked with a 4.181 times higher likelihood of upper limb pain in workers exposed for 2–4 h and a 1.885 times higher likelihood in those exposed for 4 h or more compared to workers exposed for less than 2 h. On the other hand, standing posture is associated with a 2.890 (=1/0.346) times lower likelihood of upper limb pain in workers exposed for 2–4 h as compared to those exposed for less than 2 h.

3.3.3. Factors Affecting Lower Limb Pain

Table 8 shows the percentage of nurses who experienced lower limb pain, and the lower limb pain reporting rate was 15.2%. Table 7 suggests that exposure to noise, handling heavy objects, and awkward postures for more than 4 h increases the likelihood of reporting lower limb pain.

The binary logistic regression model on lower limb pain shows a satisfactory level of explanatory power (Nagelkerke value = 0.241). Based on the Hosmer–Lemeshow test, the model was appropriate (p = 0.963), and the model's prediction accuracy was high (86.1%).

The factors that contribute to lower limb pain include awkward posture (p = 0.001), patient lifting/carrying (p = 0.002), and repetitive motion (p = 0.006).

Table 8. Results of binary logistic regression analysis with lower limb pain.

Variables	Prevalence Rate (%)	B	*p*-Value	OR	95% C.I. for OR	
					Lower	Upper
Working hours/week			0.087			
<41 (ref)	13.9%					
≥41	17.1%	0.514	0.087	1.672	0.928	3.012
Noise			0.068			
<2 h (ref)	13.6%					
2–4 h	33.3%	0.291	0.658	1.338	0.369	4.851
≥4 h	83.3%	2.690	0.022 *	14.731	1.482	146.413
Awkward posture			0.001 *			
<2 h (ref)	10.0%					
2–4 h	6.3%	−1.057	0.084	0.347	0.105	1.154
≥4 h	31.9%	0.926	0.003 *	2.523	1.360	4.681
Patient lifting/carrying			0.002 *			
<2 h (ref)	10.4%					
2–4 h	22.1%	0.938	0.006 *	2.555	1.307	4.996
≥4 h	48.3%	1.385	0.005 *	3.997	1.529	10.443
Repetitive motion			0.006 *			
<2 h (ref)	7.5%					
2–4 h	22.4%	1.358	0.003 *	3.887	1.581	9.558
≥4 h	21.4%	0.835	0.014 *	2.306	1.183	4.494
Constant		−3.207	<0.001 *	0.040		

* significant at 0.05, ref = reference, OR = odds ratio, C.I. = confidence interval.

Noise is associated with a 14.731 times higher likelihood of lower limb pain in nurses exposed for 4 h or more compared to those exposed for less than 2 h. Awkward posture is associated with a 2.523 times higher likelihood of lower limb pain in workers exposed for 4 h or more compared to those exposed for less than 2 h. Patient lifting/carrying is associated with a 2.555 times higher likelihood of lower limb pain in nurses exposed for 2–4 h and a 3.997 times higher likelihood in those exposed for 4 h or more compared to workers exposed for less than 2 h. Repetitive motion is associated with a 3.887 times higher likelihood of lower limb pain in nurses exposed for 2–4 h and a 2.306 times higher likelihood in those exposed for 4 h or more compared to workers exposed for less than 2 h.

4. Discussion

The analysis of workplace hazards and their effects on employee health is important in identifying common factors contributing to health and safety issues and in developing effective prevention programs [1].

In this study, the most common area of nurses' musculoskeletal pain was upper limb pain at 26.0%, followed by back pain at 19.0% and lower limb pain at 15.2%. The highest musculoskeletal pain among nurses was upper limb pain (26.0%), followed by back pain (19.0%) and lower limb pain (15.2%). This is a different trend from the upper limb pain (22.4%), lower limb pain (11.7%), and back pain (7.6%) of automobile assembly workers in the manufacturing industry, and the pain complaint rate was found to be higher than that of automobile assembly workers. On the other hand, the pain complaint rate among nurses was lower than that of the construction industry. However, it showed a similar trend in pain areas such as upper limb pain (30.2%), back pain (24.0%), and lower limb pain (14.1%) in the construction industry. The results from estimating exposure time to hazards in nursing indicate that the time spent in a standing posture is the highest, followed by repetitive movements, awkward postures, patient lifting/carrying, infection, handling of heavy loads, and vibrations. Common hazards that show differences in average exposure time between the group complaining of back pain, upper limb, and lower limb pain and the group not complaining of pain are noise, awkward posture, patient lifting/carrying, handling heavy loads, and repetitive motions.

A logistic regression analysis was performed to identify the factors that affect musculoskeletal pain. Factors influencing upper limb pain included worker characteristics such as rotating shift work and ergonomic factors like handling heavy loads, standing posture, and repetitive motion. Handling heavy loads stood out as the most significant factor, with employees exposed for more than 4 h having a 7.224 times higher likelihood of reporting upper limb pain than those exposed for less than 2 h. This corresponds with studies suggesting that exposure to handling heavy loads is associated with increased upper limb pain in areas such as the neck and shoulders [25,26]. Repetitive movements showed that employees exposed for 2–4 h had a 4.181 times higher likelihood of reporting upper limb pain than those exposed for less than 2 h. This aligns with research suggesting that increased exposure to repetitive movements is associated with higher levels of upper limb pain [27,28]. Nurses exposed to a standing position for less than 2 h were 2.890 times more likely to report upper limb pain than those exposed for 2 to 4 h. This is consistent with research showing that lower exposure to standing positions in the nursing profession generally leads to increased computer or upper limb tasks, which leads to increased upper limb pain [29].

According to the logistic regression model analysis results, the factors influencing back pain were identified as work experience and exposure level to awkward posture. Nurses with more than 6 years of work experience had a 2.245 times higher likelihood of complaining about back pain than those with less than 3 years of work experience. This finding is consistent with previous research indicating that individuals with more extended work experience are more prone to back pain [30,31]. Moreover, nurses working in hospitals had a 2.526 times higher likelihood of reporting back pain than those working in clinics. This corresponds with studies suggesting a higher prevalence of back pain among hospital workers than clinic workers [32,33]. For an awkward posture, nurses exposed for more than 4 h had a 3.473 times higher likelihood of reporting back pain than those exposed for less than 2 h. This finding is consistent with research highlighting awkward posture as a significant factor in low back pain [34–37].

Factors influencing lower limb pain included exposure level of awkward posture, patient lifting/carrying, and repetitive movements. Specifically, awkward posture stood out as a significant factor, with nurses exposed for more than 4 h having a 2.523 times higher likelihood of reporting lower limb pain than those exposed for less than 2 h. This aligns with research indicating that awkward postures, such as squatting, kneeling, or bending during nursing tasks, can impose excessive load on the knees, leading to lower limb pain [38]. Nurses exposed to patient lifting/carrying tasks for more than four hours have a 3.997 times higher chance of reporting lower limb pain than those exposed for less than two hours. This corresponds with studies suggesting that the load placed on the lower limbs, including the knees, during patient lifting/carrying tasks contributes to lower limb pain [38–40]. Repetitive movements showed that employees exposed for 2–4 h had a 3.887 times higher likelihood of reporting lower limb pain than those exposed for less than 2 h. This aligns with research indicating that increased exposure to repetitive movements is associated with a higher incidence of lower limb pain [34,38].

5. Conclusions

The study has certain limitations that need to be taken into account. Firstly, the investigation relied on subjective surveys instead of medically validated factors directly related to musculoskeletal disorders. This means that interpreting factors affecting musculoskeletal disorders in nursing professions needs to be undertaken with caution. Secondly, the research only focused on nursing professionals working in hospitals and clinics, excluding other healthcare settings such as public health centers, blood centers, nursing homes, and home healthcare. Therefore, it is essential to be careful while generalizing the findings to the nursing profession. Thirdly, the study did not explore the impact of psychosocial factors on musculoskeletal pain. Future research is needed to investigate the influence of psychological factors on musculoskeletal disorders. Fourth, the results of logistic regres-

sion model analysis, which categorized the independent variable into three groups (e.g., <2 h, 2–4 h, ≥2 h for exposure), may differ when evaluated in two groups (2 h vs. ≥2 h). Therefore, future research should consider the issue of overdispersion and conduct further investigations to address it.

Nevertheless, this study holds significance in identifying the exposure levels of physical, biochemical, and ergonomic hazards that could affect musculoskeletal pain in nursing professions. By considering both occupational factors and hazard exposures comprehensively, the study derived factors influencing lower back pain, upper limb pain, and lower limb pain. The findings are interpreted as providing practical assistance in managing risk factors for preventing musculoskeletal pain in nursing professions. In the future, additional research is needed to consider psychological factors in the context of musculoskeletal pain. It is anticipated that such information will contribute to formulating future prevention and improvement policies.

Author Contributions: Conceptualization, W.J.K. and B.Y.J.; methodology, W.J.K. and B.Y.J.; data collection and analysis, W.J.K.; resources, W.J.K. and B.Y.J.; data curation, W.J.K.; writing—original draft preparation, W.J.K. and B.Y.J.; writing—review and editing, W.J.K. and B.Y.J.; supervision, B.Y.J.; funding acquisition, B.Y.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research was financially supported by Hansung University.

Institutional Review Board Statement: Not applicable. Because this study used publicly available data, the Institutional Review Board exempted it from deliberation under the Bioethics and Safety Act of Korea.

Informed Consent Statement: Not applicable.

Data Availability Statement: Publicly available datasets were analyzed in this study. This data can be found here: https://www.kosha.or.kr/eoshri/resources/KWCSDownload.do (accessed on 14 February 2024).

Acknowledgments: The authors are grateful to the Occupational Safety and Health Research Institute (OSHRI) and the Korea Occupational Safety and Health Agency (KOSHA) for providing the raw data from the KWCS.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. ILO. Health Care: Its Nature and Its Occupational Health Problems. Available online: https://www.iloencyclopaedia.org/part-xvii-65263/health-care-facilities-and-services/item/433-health-care-its-nature-and-its-occupational-health-problems (accessed on 11 February 2024).
2. Korea Employment Information Service, Korea Dictionary of Occupations. Available online: https://www.keis.or.kr/user/extra/main/3875/publication/publicationList/jsp/LayOutPage.do?categoryIdx=125&pubIdx=6252&onlyList=N (accessed on 11 February 2024).
3. Cezar-Vaz, M.R.; Xavier, D.M.; Bonow, C.A.; Vaz, J.C.; Cardoso, L.S.; Sant'Anna, C.F.; da Costa, V.Z.; Nery, C.H.C.; Alves, A.S.; Vettorello, J.S.; et al. Musculoskeletal Pain in the Neck and Lower Back Regions among PHC Workers: Association between Workload, Mental Disorders, and Strategies to Manage Pain. *Healthcare* **2023**, *11*, 365. [CrossRef] [PubMed]
4. Krishnan, K.S.; Raju, G.; Shawkataly, O. Prevalence of work-related musculoskeletal disorders: Psychological and physical risk factors. *Int. J. Environ. Res. Public Health* **2021**, *18*, 9361. [CrossRef] [PubMed]
5. Ou, Y.K.; Liu, Y.; Chang, Y.P.; Lee, B.O. Relationship between Musculoskeletal Disorders and Work Performance of Nursing Staff: A Comparison of Hospital Nursing Departments. *Int. J. Environ. Res. Public Health* **2021**, *18*, 7085. [CrossRef] [PubMed]
6. Kim, J.W.; Jeong, B.Y.; Park, M.H. A Study on the Factors Influencing Overall Fatigue and Musculoskeletal Pains in Automobile Manufacturing Production Workers. *Appl. Sci.* **2022**, *12*, 3528. [CrossRef]
7. Kim, W.J.; Jeong, B.Y.; Park, M.H. Comparison of Working Conditions, Exposure to Hazard Factors, and Health Problems between Nurses and Nursing Assistants. *J. Ergon. Soc. Korea* **2023**, *42*, 247–258. [CrossRef]
8. Eurofound. Sixth European Working Conditions Survey—Overview Report. Available online: https://www.eurofound.europa.eu/en/publications/2016/sixth-european-working-conditions-survey-overview-report (accessed on 11 February 2024).
9. Davis, K.G.; Kotowski, S.E. Prevalence of Musculoskeletal Disorders for Nurses in Hospitals, Long-Term Care Facilities, and Home Health Care. *Hum. Factors* **2015**, *57*, 754–792. [CrossRef] [PubMed]

10. Ribeiro, T.; Serranheira, F.; Loureiro, H. Work related musculoskeletal disorders in primary health care nurses. *Appl. Nurs. Res.* **2017**, *33*, 72–77. [CrossRef] [PubMed]
11. Mailutha, J. Prevalence of Musculoskeletal Disorders among Nurses in Kenya: Part 1, Anthropometric Data and MSDS. *Int. J. Emerg. Technol. Adv. Eng.* **2020**, *10*, 158–163.
12. Arvidsson, I.; Gremark, J.S.; Lindegård-Andersson, A.; Björk, J.; Nordander, C. The impact of occupational and personal factors on musculoskeletal pain—A cohort study of female nurses, sonographers and teachers. *BMC Musculoskelet. Disord.* **2020**, *21*, 621. [CrossRef]
13. Yasobant, S.; Rajkumar, P. Health of the healthcare professionals: A risk assessment study on work-related musculoskeletal disorders in a tertiary hospital, Chennai, India. *Int. J. Med. Public Health* **2015**, *5*, 189–195. [CrossRef]
14. Alnaami, I.; Awadalla, N.J.; Alkhairy, M.; Alburidy, S.; Alqarni, A.; Algarni, A.; Alsherhri, R.; Amrah, B.; Allasmari, M.; Mahfouz, A.A. Prevalence and factors associated with low back pain among health care workers in southwestern Saudi Arabia. *BMC Musculoskelet. Disord.* **2019**, *20*, 56. [CrossRef] [PubMed]
15. Freimann, T.; Pääsuke, M.; Merisalu, E. Work-Related Psychosocial Factors and Mental Health Problems Associated with Musculoskeletal Pain in Nurses: A Cross-Sectional Study. *Pain Res. Manag.* **2016**, *2016*, 9361016. [CrossRef] [PubMed]
16. Jradi, H.; Alanazi, H.; Mohammad, Y. Psychosocial and occupational factors associated with low back pain among nurses in Saudi Arabia. *J. Occup. Health* **2020**, *62*, e12126. [CrossRef] [PubMed]
17. Hooftman, W.E.; Beek, A.J.V.D.; Bongers, P.M.; Mechelen, W.V. Is there a gender difference in the effect of work-related physical and psychosocial risk factors on musculoskeletal symptoms and related sickness absence? *Scand. J. Work Environ. Health* **2009**, *35*, 85–95. [CrossRef] [PubMed]
18. Cici, R.; Yilmazel, G. Musculoskeletal disorders increases the insomnia severity in nurses. *Sleep Sci.* **2022**, *15*, 1–6. [CrossRef] [PubMed]
19. OSHRI, KWCS (Korean Working Conditions Survey). Available online: https://www.kosha.or.kr/eoshri/resources/KWCSDownload.do (accessed on 11 February 2024).
20. Eurofound. 6th European Working Conditions Survey (2015) Questionnaire. Available online: https://www.eurofound.europa.eu/sites/default/files/2023-11/6th-ewcs-2015-source-master-questionnaire-final.pdf (accessed on 11 February 2024).
21. Statistics Korea. Korean Standard Classification of Occupations. Available online: https://kssc.kostat.go.kr:8443/ksscNew_web/ekssc/main/main.do# (accessed on 11 February 2024).
22. Park, H.J.; Jeong, B.Y.; Park, M.H. Comparison of Exposure Time to Hazard Factors and Health Problems among Office, Craft and Elementary Construction Workers. *J. Ergon. Soc. Korea* **2023**, *42*, 149–162. [CrossRef]
23. Washington State Department of Labor & Industries. Caution Zone Checklist. Available online: https://lni.wa.gov/safety-health/_docs/CautionZoneJobsChecklist.pdf (accessed on 11 February 2024).
24. Washington State Department of Labor & Industries. Hazard Zone Checklist. 2022. Available online: https://lni.wa.gov/safety-health/_docs/HazardZoneChecklist.pdf (accessed on 11 February 2024).
25. Smith, D.R.; Mihashi, M.; Adachi, Y.; Koga, H.; Ishitake, T. A detailed analysis of musculoskeletal disorder risk factors among Japanese nurses. *J. Saf. Res.* **2006**, *37*, 195–200. [CrossRef]
26. Smedley, J.; Inskip, H.; Trevelyan, F.; Buckle, P.; Cooper, C.; Coggon, D. Risk factors for incident neck and shoulder pain in hospital nurses. *Occup. Environ. Med.* **2003**, *60*, 864–869. [CrossRef] [PubMed]
27. Pelissier, C.; Fontana, L.; Fort, E.; Agard, J.P.; Couprie, F.; Delaygue, B.; Glerant, V.; Perrier, C.; Sellier, B.; Vohito, M.; et al. Occupational risk factors for upper-limb and neck musculoskeletal disorder among healthcare staff in nursing homes for the elderly in France. *Ind. Health* **2014**, *52*, 334–346. [CrossRef]
28. Da Costa, B.R.; Vieira, E.R. Risk factors for work-related musculoskeletal disorders: A systematic review of recent longitudinal studies. *Am. J. Ind. Med.* **2010**, *53*, 285–323. [CrossRef]
29. Park, J.K. Features of Work and Posture Analysis Outputs in General Hospital Nurses. *J. Korean Soc. Occup. Environ. Hyg.* **2019**, *29*, 375–382.
30. Tamrin, S.B.; Yokoyama, K.; Jalaludin, J.; Aziz, N.A.; Jemoin, N.; Nordin, R.; Li Naing, A.; Abdullah, Y.; Abdullah, M. The association between risk factors and low back pain among commercial vehicle drivers in peninsular Malaysia: A preliminary result. *Ind. Health* **2007**, *45*, 268–278. [CrossRef] [PubMed]
31. Thon, C.C.; Feng, P.K.; Lian, C.W. Risk factors of low back pain among nurses working in Sarawak General Hospital. *Health Environ. J.* **2016**, *7*, 13–24.
32. Kim, W.J.; Jeong, B.Y.; Park, M.H. Comparison of Working Conditions and Health-related Problems between Hospital Workers and Clinic Workers. *J. Ergon. Soc. Korea* **2022**, *41*, 31–42. [CrossRef]
33. Bernal, D.; Campos-Serna, J.; Tobias, A.; Vargas-Prada, S.; Benavides, F.G.; Serra, C. Work-related psychosocial risk factors and musculoskeletal disorders in hospital nurses and nursing aides: A systematic review and meta-analysis. *Int. J. Nurs. Stud.* **2014**, *52*, 635–648. [CrossRef] [PubMed]
34. Engels, J.A.; van der Gulden, J.W.; Senden, T.F.; van't Hof, B. Work related risk factors for musculoskeletal complaints in the nursing profession: Results of a questionnaire survey. *Occup. Environ. Med.* **1996**, *53*, 636–641. [CrossRef]
35. Freitag, S.; Ellegast, R.; Dulon, M.; Nienhaus, A. Quantitative measurement of stressful trunk postures in nursing professions. *Ann. Occup. Hyg.* **2007**, *51*, 385–395.

36. Nourollahi, M.; Afshari, D.; Dianat, I. Awkward trunk postures and their relationship with low back pain in hospital nurses. *Work* **2018**, *59*, 317–323. [CrossRef]
37. Pheasant, S.; Stubbs, D. Back pain in nurses: Epidemiology and risk assessment. *Appl. Ergon.* **1992**, *23*, 226–232. [CrossRef]
38. Li, J.; Sommerich, C.M.; Chipps, E.; Lavender, S.A.; Stasny, E.A. A framework for studying risk factors for lower extremity musculoskeletal discomfort in nurses. *Ergonomics* **2020**, *63*, 1535–1550. [CrossRef]
39. Daraiseh, N.; Genaidy, A.M.; Karwowski, W.; Davis, L.S.; Stambough, J.; Huston, R.I. Musculoskeletal outcomes in multiple body regions and work effects among nurses: The effects of stressful and stimulating working conditions. *Ergonomics* **2003**, *46*, 1178–1199. [CrossRef] [PubMed]
40. Warming, S.; Precht, D.H.; Suadicani, P.; Ebbehøj, N.E. Musculoskeletal complaints among nurses related to patient handling tasks and psychosocial factors--based on logbook registrations. *Appl. Ergon.* **2009**, *40*, 569–576. [CrossRef] [PubMed]