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Older Male Construction Workers and Sustainability: Work-Related Risk Factors and Health Problems

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Abstract: This study aims to analyze the characteristics of working conditions, exposure to risk factors, and health-related problems of older male construction workers. In this study, 1519 male construction workers were the subjects of study, and the working conditions, exposure to occupational risk factors, and physical health-related problems were compared among workers under 50 years, in their 50s, and 60 or over. Older male construction workers have lower educational backgrounds and lower average salaries. The degree of exposure to risk factors was higher in workers aged 60 or over than other age groups, such as high temperature, awkward posture, manual material handling, standing posture, repetitive motion, fumes/dust, vapor, skin contact, and tobacco smoke. In addition, the complaint rate of hearing problems, overall fatigue, backache, upper limb pain, or lower limb pain was higher in older workers. In particular, the complaint rate of musculoskeletal pain was 56.6%, overall fatigue was 40.3%, and the rate of depression symptoms was 41.9%. This study shows a high prevalence of musculoskeletal disorders, overall fatigue, and depression symptoms of male elderly construction workers, suggesting that comprehensive support is needed to improve not only the working conditions of workers but also psychological health problems.

Keywords: hazard exposure; musculoskeletal pain; overall fatigue; depression

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1. Introduction

1.1. Purpose of Study

Construction workers build, repair, maintain, modify, and demolish various buildings and structures [1]. The construction industry process is high-risk because it involves complex, dynamic, ad hoc, and complicated tasks and work environments such as high temperature, limited space, temporary fixtures, dark lighting, hazardous substances [2–8]. Thus, construction workers have a high risk of occupational injuries and poor health [2–4,7,8].

The construction industry in South Korea suffers a lot of injuries and illnesses, especially deaths. According to the 2020 industrial accident statistics of South Korea [9], out of 18,974,513 workers in all industries in Korea, 2,284,916 workers (12.0%) were in the construction industry. Of the 108,379 injuries and illnesses in all industries, 26,799 (24.7%) occurred in the construction industry [9]. The accident rate in the construction industry was 1.17, which was 2.05 times higher than the accident rate of 0.57 across all industries. In addition, of the 2062 deaths in the whole industry, 567 (27.5%) died in the construction industry [9]. The death per 10,000 workers in the construction industry was 2.48, which is 2.27 times higher than that of the entire industry, the highest among all industries.

Working environment and hazards are related to workers' health and safety [8]. Construction work is performed in the working environment exposed to physical hazards (such as noise, vibration, high temperature, and low temperature) or chemical hazards (such as dust and toxic substances). It is also ergonomically hazardous, requiring awkward postures, manual materials handling, and forceful exertions [4,8,10–12]. Construction workers are also exposed to a wide variety of psychological hazards [8,12]. They are often faced

with problems such as changing workplaces, subcontracting, turnover, and short-term employment [4,6]. These physically and psychologically hazardous situations influence many aspects of occupational injuries or health-related problems [12–22]. Thus, they are highly likely to experience fatigue, sleep-related problem, or depression [12,13,17,19,21,22].

Furthermore, the construction industry of South Korea is also experiencing aging and masculinity in terms of occupational injuries and illnesses [3,4,8,11]. The proportion of elderly workers aged 60 and over was 36.4%, which is high compared to 29.0% across all industries [23]. In 2019, men accounted for 97.1% of injuries and illnesses in the construction industry [23].

Identification of occupational hazards is fundamental to establishing a healthy workplace [7,11]. However, despite the aging and masculinity of occupational injuries and illnesses in the construction industry [3,4,8,11], there is a lack of studies to systematically analyze the exposure to hazards and health status for older construction workers. Therefore, this study aims to investigate the working conditions, exposure to hazards, and health status of older male workers in the construction industry of South Korea.

1.2. Theoretical Background and Hypotheses

1.2.1. Construction Workers

Construction workers are usually hired per project and can only spend weeks or months on one project [7]. When one project is completed, workers and employers move on to other projects to start all over again [6,7]. Thus, it is difficult for a temporary worker to recognize hazards when the work environment changes all the time [7,12]. Furthermore, workers of construction sites require dangerous and strenuous physical activity [4].

In addition to the poor working environment, construction workers of South Korea have lower incomes and educational backgrounds than other industries [3,4,24]. Previous studies suggested that older workers, temporary contract workers, long-worktime workers, or low-income workers were more vulnerable to have occupational accidents and health problems [3,4,12,25–27]. As the number of older workers in the construction industry is increasing [3,4,23], understanding the working conditions of older workers is very important for preventing work-related accidents and health problems. Thus, it is necessary to examine whether the contract period, educational background, working hours, and wages of older workers differ from those of other age groups.

This study established hypotheses to test the educational background or employment contract period distributions by age group. In addition, the hypotheses were established to test for mean comparison of work experience, weekly working hours, or monthly income by age group.

1.2.2. Working Environment and Hazards on Construction Sites

Hazards of workplaces are typical of four classes: chemical, biological, physical, and ergonomic hazards [28,29].

Chemical hazards manifest as airborne dust, mists, vapors, or gases, while biological hazards arise from exposure to toxic substances or infectious microorganisms [28,29]. Exposure to chemical and biological hazards usually occurs by inhalation but may be absorbed through the skin [28,29]. Dust, chemicals, and potentially hazardous mixtures are common in construction work, which can cause breathing problems and dermatitis [8].

Physical hazards include noise, heat and cold, and vibration [26]. Construction work is often done in hot, cold, rain, or snowy weather or at night [20,28,29]. Construction is also one of the industries with high health problems due to noise and vibration [11].

Ergonomic hazards are excessive force, uncomfortable working postures of frequent bending and twisting, and repetitive movements [4,28,29]. In the construction industry, awkward postures, handling of heavy objects, standing postures, and repetitive motions are typical, and these ergonomic hazards can cause musculoskeletal pains [4,8,10–12,16,30].

Examining exposure to occupational hazards at work of older construction workers can help control various hazards to ensure a healthy workplace [5,31,32]. It also helps

determine whether older workers work in harsh conditions or are more susceptible to hazards even when working in the same conditions. The hypotheses were established to test for mean comparison of physical, ergonomic, or chemical/biological hazard exposure by age group.

1.2.3. Work-Related Health Problems

Poor working conditions and low social support can cause construction workers to have physical/psychological health problems [12,13,22]. Construction workers are vulnerable to pains and injuries in the musculoskeletal system due to laborious and strenuous physical work [7,8,10–12,16,30]. Furthermore, construction jobs may lack social support networks as workers may have to leave their homes and families to live on construction sites [13,19,21,29].

Previous findings indicate that older workers are vulnerable to musculoskeletal pain [8,10,16], and are prone to fatigue, sleep-related problems, and depression due to job insecurity and lack of social support [7,12,17,29]. If the occurrence characteristics of musculoskeletal disorders and depression in elderly workers differ according to age, it is important to understand the characteristics of the occurrence of the elderly in order to establish customized preventive measures. The hypotheses were established in order to test the distributions of the health-related problems by age group.

2. Materials and Methods

2.1. Data Collection

This study was conducted using the raw data of the 5th Korean Working Conditions Survey (KWCS) [33]. The KWCS is a national survey to investigate workers' working conditions and risk factors by industry [33]. In the 5th KWCS, 50,205 workers participated in proportion to each region's population in Korea. A professional interviewer conducted a KWCS, and participants received a fee [33]. The response rate of KWCS was 0.449.

According to the Korean Standard Industrial Classification [1], we extracted construction workers and filtered 1519 male construction workers as subjects. They consisted of 38.2% under 50 years, 36.3% in their 50s, and 25.5% in their 60 or older.

The raw data of the KWCS is open to the public to promote secondary analysis. This study was exempted from the deliberation by the Institutional Review Board, under Article 15 (2) of the Bioethics and Safety Act of Korea [34], because it used the publicly available data.

2.2. Research Variables

Research variables were composed of worker characteristics, work environment characteristics, and health problem characteristics among the KWCS questionnaire [33] and the EWCS questionnaire [35]. Table 1 shows the research variables, related descriptions (or questions), and observed scores. We organized the age groups of workers into under 50, the 50s, and 60 or over. Older workers mean workers aged 60 or over. Worker characteristics consisted of respondent's education level, employment contract, work experience, working hours per week, average monthly income.

The characteristics of the working environment include physical hazards (vibration, noise, high temperature, low temperature), chemical and physiological hazards (fumes and dust, vapor, skin contact, infection), ergonomic hazards (awkward posture, handling of heavy objects, standing posture, and repetitive motion), and satisfaction with the working conditions.

Table 1. Research variables of this study.

Factor	Variable	Description	Observed Score
	Workers (Respondents)		
		Age	<50, 50s, ≥60 years
		Employment contract	<1 month, <1 year, ≥1 year
		Education level	Elementary, middle, high school, over college
		Monthly income	million KRW
		Work experience	Years
		Working hours/week	Hours
	Working environment:	'Please tell me, using the following scale, are you exposed at work to?'	
	Physical hazards		
		Vibration	1 = Never, 2 = Almost never, 3 = 1/4 time, 4 = 1/2 time, 5 = 3/4 time, 6 = Most of the time, 7 = Always
		Noise	
		High temperature	
		Low temperature	
	Chemical/biological hazards		
		Fumes, dust	1 = Never, 2 = Almost never, 3 = 1/4 time, 4 = 1/2 time, 5 = 3/4 time, 6 = Most of the time, 7 = Always
		Vapor	
		Skin contact with chemical	
		Infection	
	Ergonomic hazards		
		Awkward posture	1 = Never, 2 = Almost never, 3 = 1/4 time, 4 = 1/2 time, 5 = 3/4 time, 6=Most of the time, 7 = Always
		Handling of heavy objects	
		Standing posture	
		Repetitive motion	
		:	
	Satisfaction with working conditions:	'What do you think of the overall working conditions?'	
		Satisfaction with working conditions	Not at all satisfied, Not very satisfied, Satisfied, Very satisfied
	Health problems		
	Physical problem:	'Over the last 12 months, did you have any of the following health problems?'	
		Hearing problems	1 = Yes, 0 = Other
		Skin problems	
		Headache and eyestrain	
		Overall fatigue	
	MSDS problem:	'Over the last 12 months, did you have any of the following health problems?'	
		Backache	1 = Yes, 0 = Other
		Upper limb pain	
		Lower limb pain	
	Wellbeing score:	'Which is the closest to how you have been feeling over the last two weeks?'	
		I have felt cheerful and in good spirits.	1 = Some of the time, 2 = Under 1/2 time, 3 = Over 1/2 time, 4 = Most of the time, 5 = All of the time
		I have felt calm and relaxed.	
		I have felt active and vigorous.	
		I woke up feeling fresh and rested.	
		My daily life has been filled with things that interest me.	
		Total wellbeing score	5–25

Health-related characteristics are expressed as complaints of physical health problems (hearing problems, skin problems, headache and eyestrain, overall fatigue), complaints of musculoskeletal pain (backache, upper limb pain, lower limb pain), and wellbeing score or depression symptoms. As shown in Table 1, physical health problems or MSDs complaints were assessed in response to the question "Over the last 12 months, did you have any of the following health problems?" Wellbeing score was assessed using a 5-item World Health Organization Well Being Index (WHO-5) [36,37]. The wellbeing score was rated in response to the question, "Which is the closest to how you have been feeling over the last two weeks?" The WHO-5 is also a self-rated measure for depression symptoms [37]. If the total wellbeing score of 5 items is less than 13 points, it is evaluated as a depression symptom [36,37].

2.3. Data Analysis

In this study, the χ^2 test is performed to test whether there is a difference in the distribution of characteristics of each age group according to each independent variable in worker characteristics and health-related perception problem characteristics. In addition, we intend to conduct an analysis of variance (ANOVA) to see if there are differences in the averages for each age group in terms of monthly income, work experience, working hours per week, exposure to risk factors in the working environments or wellbeing score. The statistical package used for statistical analysis was SPSS 18.0, and the significance level was 0.05.

3. Results

3.1. Characteristics of Respondents

3.1.1. Distributions of Respondents by Age and Education Level

Table 2 shows the distribution of the education level of respondents according to age group. In Table 2, as for the educational level of male construction workers, high school graduates accounted for 52.1%, college or higher graduates 24.4%, and middle school graduates 17.1%.

Table 2. Distribution of respondents by age group and education level.

Age (Years)		Elementary School	Middle School	High School	Over College	Total
<50	N	4	24	299	253	580
	%	0.7%	4.1%	51.6%	43.6%	100.0%
50s	N	23	100	341	88	552
	%	4.2%	18.1%	61.8%	15.9%	100.0%
≥60	N	72	135	151	29	387
	%	18.6%	34.9%	39.0%	7.5%	100.0%
Total	N	99	259	791	370	1519
	%	6.5%	17.1%	52.1%	24.4%	100.0%

There was a difference in the distribution of education level according to age group ($\chi^2 = 423.189$, $p < 0.001$). Among workers under 50 years, 95.2% had a high school diploma or higher, whereas 53.5% of workers aged 60 years or over had a middle school education or less, indicating that their educational attainment decreased as their age increased.

3.1.2. Distributions of Respondents by Age and Employment Contract

Table 3 shows the distribution of employment contracts by age group. In Table 3, workers with an employment contract of one year or longer accounted for 46.3% of all workers, workers with an employment contract of one month to less than one year 45.8%, and workers with an employment contract of less than one month 7.9%.

Table 3. Distributions of respondents by age and employment contract.

Age (Years)		≥1 Year	<1 Year	<1 Month	Total
<50	N	288	32	119	439
	%	65.6%	7.3%	27.1%	100.0%
50s	N	150	27	191	368
	%	40.8%	7.3%	51.9%	100.0%
≥60	N	60	26	182	268
	%	22.4%	9.7%	67.9%	100.0%
Total	N	498	85	492	1075
	%	46.3%	7.9%	45.8%	100.0%

The distribution of employment contracts differed according to age group (χ^2 = 137.419, $p < 0.001$). Among those under 50, 65.6% were workers with one year or more contract, while 67.9% of those aged 60 or over had less than one month. Furthermore, the proportion of workers less than one month of the contract increased with increasing age.

3.1.3. Work Experience, Working Days, and Monthly Income

Table 4 shows the mean and standard deviation of work experience, working hours per week, and monthly income according to age group. In Table 4, the mean work experience increased according to age (F = 105.753, $p < 0.001$), and the working hours per week decreased with age (F = 24.959, $p = 0.021$). The monthly income of those in their 50s was highest at 3.824 million won, followed by 3.712 million won for those under 50, and 3.225 million won for those over 60 (F = 27.118, $p < 0.001$).

Table 4. Comparison of work experience, working hours, and wage.

Age (Years)		Work Experience (Years)	Working Hours/Week	Monthly Income (KRW Million)
<50	Mean	6.754	46.379	3.712
	SD	6.135	10.184	1.221
50s	Mean	13.020	45.717	3.824
	SD	9.639	10.551	1.299
≥60	Mean	15.325	41.578	3.225
	SD	13.098	12.213	1.317
Total	Mean	11.225	44.916	3.628
	SD	10.236	11.036	1.296
Mean Test	F	105.753	24.959	27.118
	p	$p < 0.001$ *	$p < 0.001$ *	$p < 0.001$ *

* significant at 0.05.

3.2. Working Conditions and Hazard Exposures

3.2.1. Physical Hazard Exposures

The degree of exposure to physical hazard was investigated with the question "Please tell me, using the following scale, are you exposed at work?" Table 5 expresses the degree of exposure to physical hazards on a 7-point scale. Overall, the degree of exposure to physical hazards was highest in vibration (3.760), followed by high temperature (3.355), noise (3.109), and low temperature (2.840).

It was found that there was a difference by age in the perception of the level of exposure to high temperatures. High-temperature exposure was the highest among those aged 60 and over (3.574), followed by those in their 50s (3.395) and under 50 (3.171). It decreased with increasing age (F = 6.425, $p = 0.002$).

Table 5. Comparisons of physical hazard exposures.

Age (Years)		Vibration	Noise	High Temperature	Low Temperature
<50	Mean	3.802	3.036	3.171	2.793
	SD	1.752	1.561	1.695	1.549
50s	Mean	3.723	3.138	3.395	2.784
	SD	1.698	1.532	1.771	1.549
≥60	Mean	3.752	3.178	3.574	2.990
	SD	1.749	1.533	1.777	1.680
Total	Mean	3.760	3.109	3.355	2.840
	SD	1.731	1.543	1.750	1.585
Mean test	F	0.300	1.131	6.425	2.323
	p	0.741	0.323	0.002 *	0.098

* significant at 0.05, Note: Mean score = 1: Never, 2: Almost never, 3: 1/4 time, 4: 1/2 time, 5: 3/4 time, 6: Most of the time, 7: Always.

3.2.2. Ergonomic Hazard Exposures

Table 6 expresses the degree of exposure to ergonomic hazards on a 7-point scale. As for the subjective symptom score for exposure to the ergonomic hazard, repetitive motion (4.621) was the most exposed, followed by standing posture (4.608), awkward posture (4.139), and material handling (3.729).

Table 6. Comparisons of ergonomic hazard exposures.

Age (Years)		Awkward Posture	Material Handling	Standing Posture	Repetitive Motion
<50	Mean	3.945	3.602	4.464	4.534
	SD	1.677	1.529	1.564	1.760
50s	Mean	4.141	3.721	4.656	4.578
	SD	1.663	1.504	1.579	1.790
≥60	Mean	4.426	3.930	4.757	4.811
	SD	1.626	1.561	1.581	1.739
Total	Mean	4.139	3.729	4.608	4.621
	SD	1.668	1.533	1.578	1.768
Mean test	F	9.780	5.373	4.425	3.110
	p	< 0.001 *	0.005*	0.012 *	0.045 *

* significant at 0.05, Note: Mean score = 1: Never, 2: Almost never, 3: 1/4 time, 4: 1/2 time, 5: 3/4 time, 6: Most of the time, 7: Always.

Awareness of exposure to ergonomic hazards was different by age group. Awkward posture ($F = 9.780$, $p < 0.001$), material handling ($F = 5.373$, $p = 0.005$), standing posture ($F = 4.425$, $p = 0.012$), repetitive motions ($F = 3.110$, $p = 0.045$) was different by age group, and they increased with age.

3.2.3. Chemical and Biologic Hazard Exposures

Table 7 expresses the degree of exposure to chemical and biological hazards on a 7-point scale. The subjective score for exposure to chemical and biological hazards was highest for fumes/dust (3.306), followed by tobacco smoke (2.541), vapor (2.282), skin contact (2.210), and infection (1.935).

In Table 7, there were differences by age, except for infection, in the perception of exposure to chemical and biological hazards. Exposure scores to fumes/dust ($F = 5.960$, $p = 0.003$), vapors ($F = 3.495$, $p = 0.031$), skin contact ($F = 5.558$, $p = 0.004$), and tobacco smoke ($F = 5.764$, $p = 0.003$) were high in the age group over 60 years old, and the subjective scores increased as the age increased.

Table 7. Comparisons of chemical and biological hazard exposures.

Age (Years)		Fumes/Dust	Vapor	Skin Contact	Smoke	Infection
<50	Mean	3.122	2.181	2.100	2.431	1.855
	SD	1.735	1.247	1.153	1.162	.989
50s	Mean	3.370	2.303	2.214	2.551	1.982
	SD	1.692	1.311	1.284	1.155	1.066
≥60	Mean	3.491	2.403	2.370	2.693	1.990
	SD	1.715	1.363	1.270	1.226	0.974
Total	Mean	3.306	2.282	2.210	2.541	1.935
	SD	1.720	1.303	1.236	1.180	1.015
Mean test	F	5.960	3.495	5.558	5.764	2.952
	p	0.003*	0.031 *	0.004 *	0.003 *	0.053

* significant at 0.05, Note: Mean score = 1: Never, 2: Almost never, 3: 1/4 time, 4: 1/2 time, 5: 3/4 time, 6: Most of the time, 7: Always.

3.2.4. Satisfaction with Working Conditions

The subjective satisfaction with working conditions was investigated with the question "What do you think of the overall working conditions?" Table 8 shows the distribution of subjective satisfaction with the working conditions, and it was found that 60.0% were satisfied with the working conditions.

Table 8. Satisfaction with the working environment.

Age (Years)	What Do You Think of the Overall Working Conditions?				
	Not at All	Not Very Satisfied	Satisfied	Very Satisfied	Total
<50	29	178	359	14	580
	5.0%	30.7%	61.9%	2.4%	100.0%
50s	24	195	326	7	552
	4.3%	35.3%	59.1%	1.3%	100.0%
≥60	22	160	196	9	387
	5.7%	41.4%	50.6%	2.3%	100.0%
Total	75	533	881	30	1519
	4.9%	35.1%	58.0%	2.0%	100.0%

Note: significant at 0.05 (χ^2 = 15.790, p = 0.015).

In Table 8, in the distribution of satisfaction scores on the working conditions by age, the ratio of satisfaction with the working conditions decreases with age (χ^2 = 15.790, p = 0.015). The satisfaction rate of those under 50 years old was 64.3%, while those over 60 years old showed 52.9%.

3.3. Comparison of Self-Reported Health Problems

3.3.1. Physical Health Problems

Table 9 shows the distribution of responses to the question, "Over the last 12 months, did you have any of the following physical health problems." Among physical health problems, the complaint rate for overall fatigue was the highest at 36.4%, followed by headache and eyestrain (12.9%), hearing problems (2.8%), and skin problems (1.3%).

For overall fatigue (χ^2 = 15.790, p = 0.015) and hearing problems (χ^2 = 15.790, p = 0.015), the complaint rate of workers over 60 years old was higher than that of workers under 50 years old.

Table 9. Ratios of self-reported physical health problems.

Age (Years)		Hearing Problem	Skin Problem	Headache and Eyestrain	Overall Fatigue
<50	N = 580	13	7	69	180
	%	2.2%	1.2%	11.9%	31.0%
50s	N = 552	12	5	71	217
	%	2.2%	0.9%	12.9%	39.3%
≥60	N = 387	18	8	56	156
	%	4.7%	2.1%	14.5%	40.3%
Total	N = 1519	43	20	196	553
	%	2.8%	1.3%	12.9%	36.4%
$\chi 2$ test	$\chi 2$	6.261	2.499	1.369	11.789
	p	0.044 *	0.294	0.504	0.003 *

* significant at 0.05.

3.3.2. Subjective Musculoskeletal Pains

Table 10 shows the distribution of complainants of musculoskeletal pain by age group. The rate of upper limb pain was the highest at 42.6%, followed by lower limb pain (27.5%) and backache (19.2%).

Table 10. Ratios of subjective musculoskeletal pains.

Age (Years)		Backache	Upper Limb Pain	Lower Limb Pain
<50	N = 580	98	206	118
	%	16.9%	35.5%	20.3%
50s	N = 552	103	246	163
	%	18.7%	44.6%	29.5%
≥60	N = 387	91	195	136
	%	23.5%	50.4%	35.1%
Total	N = 1519	292	647	417
	%	19.2%	42.6%	27.5%
χ^2 test	χ^2	6.724	22.370	27.397
	p	0.035*	<0.001 *	<0.001 *

* significant at 0.05.

Backache ($\chi^2 = 6.724$, $p = 0.035$), upper limb pain ($\chi^2 = 22.370$, $p < 0.001$), and lower limb pain ($\chi^2 = 27.379$, $p < 0.005$) were different by age group, and the complaint rate increased with age.

Table 11 shows the number of musculoskeletal pain areas by age group among backache, upper limb pain, and lower limb pain. The rate of complaining of any pain among three sites was 48.4%, and 30.5% in two or more sites.

Table 11. The number of musculoskeletal pain regions.

Age (Years)	No. of Musculoskeletal Pain Regions				Total
	0	1	2	3	
<50	345	91	101	43	580
	59.5%	15.7%	17.4%	7.4%	100.0%
50s	271	108	115	58	552
	49.1%	19.6%	20.8%	10.5%	100.0%
≥60	168	72	91	56	387
	43.4%	18.6%	23.5%	14.5%	100.0%
Total	784	271	307	157	1519
	51.6%	17.8%	20.2%	10.3%	100.0%
χ^2 test	$\chi^2 = 30.882$, $p < 0.001$ *				

* significant at 0.05.

There was a difference in the distribution of the number of musculoskeletal pain regions by age group ($\chi^2 = 30.882$, $p < 0.001$). Even in one region, the rate of musculoskeletal pain was 40.5% for those under 50 years old and 56.6% for those over 60 years old. The rate of musculoskeletal pain in two or more regions was 24.8% for those under 50 and 38.0% for those over 60.

3.3.3. Wellbeing Score and Depression Symptom

Table 12 shows the average wellbeing score and the distribution of depression symptoms by age group. There was a difference in the mean test for the wellbeing score ($F = 9.030$, $p < 0.001$), and it was found that the mean wellbeing score decreased with age.

Table 12. The wellbeing score and depression symptom ratio by age group.

Age (Years)	Wellbeing Score			
	Mean Test		Depression Symptom ** Ratio	
<50	Mean	14.338	N = 580	187
	SD	5.115	%	32.2%
50s	Mean	13.504	N = 552	205
	SD	5.287	%	37.1%
≥60	Mean	12.910	N = 387	162
	SD	5.397	%	41.9%
Total	Mean	13.671	N = 1519	554
	SD	5.278	%	36.5%
Testing	*F*	9.030	χ^2	9.436
	p	< 0.001*	*p*	0.009 *

* significant at 0.05; ** Wellbeing score < 13.

In Table 12, the rate of depression symptoms was 36.5%. There was a difference by age in the distribution of depression symptoms ($\chi^2 = 9.436$, $p = 0.009$), and the proportion of depression symptoms increased with age. The proportion of depression symptoms among those under the age of 50 was 32.2%, while those over 60 were 41.9%.

4. Discussion

Analysis of exposure to hazards and workers' health in the working environment is used to identify common factors contributing to health and safety and develop health prevention programs [29,38]. This study investigated the overall characteristics of the working environment, exposure to risk factors, and health problems of construction workers. In addition, the characteristics of older workers were emphasized by comparing the features of each age group.

Construction workers complained that exposure to ergonomic hazards was the highest among various hazards. Repetitive motion (4.621) showed the highest degree of exposure to risk factors perceived by construction workers, and they complained that standing posture (4.608) and awkward posture (4.139) were exposed for more than 1/2 time of their work. Respondents also complained that they were exposed to vibration (3.760), high temperature (3.335), fumes/dust (3.306), and noise (3.209) for about a quarter of their working hours. Additionally, 36.4% of the respondents experienced overall fatigue in the past 12 months. These results align with previous studies [8,29] that construction workers work outdoors in summer or winter and are highly fatigued due to high-intensity physical activity in environments such as noise, vibration, and dust. Previous studies have also indicated that controlling exposure to various hazards is essential to ensure a healthy workplace [5,31,32]. Gunduz and Ahsan [2] emphasized that interventions to ensure safety from risk exposure are (1) provision of protective equipment, (2) provision of job-specific training and information, and (3) safety meetings for risk awareness.

Above all, in the results of this study, elderly workers showed different responses from other age groups in exposure to hazards. Older workers responded that they had more

exposure time than other age groups to high temperatures, awkward posture, material handling, standing posture, repetitive motion, fumes/dust, vapor, skin contact, and tobacco smoke. The working hours of older workers were shorter than those of other age groups. However, they responded that exposure to hazards was higher than that of different age groups. This means that elderly workers may feel more sensitive to pain and exposure to hazards. This suggests that improving exposure to hazards is essential for older workers to promote health, safety, and comfort [13,29]. The safety and health of workers are affected by the hazard's concentration, frequency, or duration [13]. Since older workers at construction sites work as short-term workers, their exposures to hazards are intermittent [29]. Therefore, improvements that reduce the concentration or intensity of hazards are more effective for older construction workers than reducing the duration or frequency of exposure [29].

In this study, the rate of complaints of upper limb pain (42.6%), lower limb pain (27.5%), or back pain (19.2%) was high, and the rate of complaints of musculoskeletal pain in one or more areas was 48.4%. These results are consistent with previous studies that construction workers have a high prevalence of musculoskeletal pains or disorders [8,10,35]. Furthermore, older construction workers reported higher pain complaint rates than other age groups in upper limb pain (50.4%), lower limb pain (35.1%), and backache (23.5%). The onset of musculoskeletal disorders is associated with reduced quality of life of older workers [8,10]. Because musculoskeletal disorders can be detected early, and a detailed history of musculoskeletal disorders can be used as a basis for medical advice [10]. Thus, a program that periodically examines symptoms and identifies work factors is effective [10]. Construction sites are far from medical institutions, so mobile medical services that provide on-site services are recommended [13]. In particular, it can be more effective if the company's occupational health program and cooperation with medical institutions are designed to allow regular health checkups and follow-up management and treatment for test results [13]. Medical health programs should also include providing workers with health education and information on avoiding commonly known occupational hazards [2,13,31].

The employment of construction workers differs according to the construction site's location, and the employment period is also intermittent, resulting in poor employment stability [19,29]. This study showed that 45.8% of all construction respondents worked on an employment contract of less than one month. It is consistent with the results of previous studies on the characteristics of short-term and non-regular workers in the construction industry [4,5,31,32]. Furthermore, social support networks may be lacking as construction activities are far from home and family [8,12,13,29]. Previous studies have pointed out that construction workers may suffer from fatigue, sleep-related problem, and depression due to job insecurity and lack of social support [7,8,12,19,22,29]. In this study, according to the WHO-5 index, 36.5% of all construction respondents also had symptoms of depression. These fatigue and health-related problems affect the high prevalence of accidents and injuries in the construction industry [39]. These results show a high prevalence of construction workers' overall fatigue and depression symptoms, suggesting that comprehensive support is needed to improve the psychological health-related hazards.

Like previous studies [40,41], this study found that older workers had more occupational health problems than younger workers. Of the elderly construction workers, 40.3% experienced overall fatigue, 56.6% felt musculoskeletal pain in one or more areas, and 41.9% had depression symptoms. In addition, 53.5% of them have an educational background below middle school, and 67.9% worked on contracts for less than one month. Therefore, their ability to pay medical expenses may be low, leading to low access to medical institutions. They tend to keep working unless pain persists to an unbearable level [8]. Therefore, it is difficult to receive adequate treatment, the risk of depression is high, and patients with chronic medical conditions are more vulnerable to depression [42]. Health problems can be prevented from progressing by early detection and proper treatment [13]. Thus, it indicates the need to use health education or primary care to improve early intervention [27,43]. Chung et al. [8] recommended more cost-effective health education at the

workplace on self-help pain relief methods such as stretching exercises, sleep improvement, and mindfulness.

"Decent work" has become the UN's 2030 Agenda for Sustainable Development [44]. Safe and healthy working conditions are a crucial indicator for "decent work" [45]. Furthermore, occupational safety and health are essential for a sustainable society where workers can enjoy healthy and productive lives during and after work [46,47]. A mismatch between workers' capacity and work demands increases the risk of musculoskeletal disorders, poor productivity, and occupational injuries [41]. Magnavita [48] argues that the aging of the active population means that health promotion is a necessity rather than a mere option. This study indicates that a customized safety and health promotion program is essential to secure physical and mental health for the sustainable work of older workers in the construction industry.

This study has some limitations. First, the KWCS data used in this study may not capture all construction industries. Although this study targeted construction workers composed of various occupations among the KWCS data, it could not explain the differences by occupation. Therefore, additional research reflecting the characteristics of each job type and various factors is expected. Second, since it is a cross-sectional, qualitative study, it was not possible to identify factors affecting the health or satisfaction of construction workers. Therefore, additional research is needed to elucidate the relationship between variables. Lastly, the symptoms of depression were selected using the WHO-5 index, and this study did not include an accurate clinical diagnosis. Therefore, it is difficult to generalize the results for depression.

5. Conclusions

This study is meaningful because it systematically derived the working conditions, exposure to risks, and health-related problems experienced by male construction workers.

According to the results of this study, older workers complained that exposure to high temperature, awkward posture, material handling, standing posture, repetitive motion, fumes/dust, vapor, skin contact, or tobacco smoke was higher than that of other age groups. On the other hand, in the health-related problems of elderly construction workers, the complaint rates of musculoskeletal-related pains such as upper limb pain, lower limb pain, and backache were high, as well as those with overall fatigue and depression.

This study shows a high prevalence of musculoskeletal disorders, overall fatigue, and depression symptoms of male elderly construction workers, suggesting that comprehensive support is needed to improve not only the working conditions of workers but also psychological health problems. Furthermore, this study indicates that a customized health promotion program is essential to secure physical and mental safety and health for the sustainable work of older workers in the construction industry.

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