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Incidence and Risk Factors of the Upper-Limb Musculoskeletal Disorders Among Occupational Groups in Key Industries — China, 2018–2021

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Summary

What is already known about this topic?

The burden of illness and economic losses due to upper-limb work-related musculoskeletal disorders (UL-WMSDs) is high; thus, they have become a major global public health problem. At present, the epidemiological characteristics of UL-WMSDs in China's occupational population are still unknown.

What is added by this report?

The incidence of UL-WMSDs among key occupational groups in China is 22.5%, with distinct occupational characteristics.

What are the implications for public health practice?

This study has primarily determined the occurrence and potential risk factors of UL-WMSDs in key industries in China and provided data support for recommending prevention and control of the occurrence of such diseases in key industries in China, and in facilitating the addition into the China's List of Legal Occupational Diseases.

Upper limb work-related musculoskeletal disorders (UL-WMSDs) are the most common after lower back pain and have been included in the list of occupational diseases by the International Labor Organization (ILO). In recent years, WMSDs have been widespread among the Chinese occupational populations, leading to job replacement and long-term sick leave. It is difficult to add UL-WMSDs to China's List of Legal Occupational Diseases because data on the occurrence of UL-WMSDs and their relationship with specific works are lacking. Therefore, this study included a large sample to conduct an epidemiological investigation and research into the occurrence of UL-WMSDs in key industry populations in different regions of China. The results showed the standardized incidence of UL-WMSDs in crucial industries or occupational groups in China is 22.5%. The risk of UL-WMSDs changes with the length of service, type of work, work posture, work organization, and other factors. The results may provide data support for recommending the prevention and control of such diseases and their inclusion in China's List of Legal Occupational Diseases.

The research data included in this study were obtained from seven China regions (North, East, Central, South, Southwest, Northwest, and Northeast China), and included data from 21 industries or operations, such as automobile manufacturing, furniture manufacturing, and the footwear industry. In this study, we used a stratified cluster sampling method; the workers on duty were the study participants. The inclusion criteria for subjects were employed for more than a year. The exclusion criteria were as follows: patients with congenital spinal deformity and those with non-WMSDs due to trauma, infectious diseases, and malignant tumors. This study has been reviewed by the Medical Ethical Review Committee of the Occupational Health and Poison Control at the Chinese Center for Disease Control and Prevention.

To conduct this survey, experts used the Ergonomic Evaluation and Analysis System of WMSDs provided by the Department of Occupational Protection and Ergonomics of the National Institute of Occupational Health and Poison Control of the Chinese Center for Disease Control and Prevention was used to investigate the incidence of WMSDs and its influencing factors in participants from key industries or occupational groups in different regions of China. The system includes four other sub-systems: an electronic ergonomics survey and

evaluation tool for remote operation site, a real-time data monitoring system, a data transmission network, and a background data terminal. This study's survey tool (the Chinese electronic version of the musculoskeletal disorders questionnaire) was one of the built-in questionnaires in the system, namely. This electronic questionnaire system was based on the Nordic Musculoskeletal Disorders Questionnaire (NMQ) and Dutch Musculoskeletal Questionnaire (DMQ) (*1*–*2*). After appropriate modification, it was shown to have good reliability and validity, and can be used for Chinese occupational populations. After the survey data were exported from the backend database, they were statistically processed using SPSS 20.0 statistical software (version 20.0, SPSS Inc, Chicago, IL, USA). Based on China's population composition data, the standardized incidence rate of upper-limb musculoskeletal disorders was calculated using the direct method. The single-factor analysis of WMSDs adopts the χ^2 test method, multivariate analysis was performed using an unconditional logistic regression model.

Till date, 72,029 valid questionnaires have been received. Table 1 shows that the standardized rate of UL-WMSDs in key industries or occupational groups in China was 22.5%, and the standardized rates differed significantly between different industries (P<0.05). The standardized incidence rates (ranked from the highest to the lowest) in the top five industries were animal husbandry (40.8%), biopharmaceutical product manufacturing (36.8%), civil aviation (32.5%), healthcare industry (31.5%), ferrous metal smelting and rolling processing industry (29.9%).

TABLE 1. Prevalence of upper-limb musculoskeletal disorders in key industries or occupational groups in China, 2018–2021 (n=72,029).

Industry/working group	Number	Upper-limb musculoskeletal disorders		
		n	p_i (%)	p' (%)
Total	72,029	18,193	25.3	22.5
Animal husbandry	246	62	25.2	40.8
Biopharmaceutical manufacturing	285	115	40.4	36.8
Civil aviation	1,356	420	31.0	32.5
Healthcare industry	6,961	2,520	36.2	31.5
Ferrous metal smelting and rolling	1,921	444	23.1	29.9
Cement, lime, and gypsum manufacturing	193	22	11.4	25.4
Nonferrous metal smelting and rolling processing industry	2,364	696	29.4	25.0
Computer, communication industry, and other electronic equipment manufacturing	8,910	2,229	25.0	23.3
Automobile manufacturing	21,598	5,730	26.5	22.0
Toy manufacturing	333	141	42.3	20.4
Automobile repair and maintenance	802	145	18.1	19.2
Footwear industry	7,123	1,844	25.9	18.2
Coal mining, and washing	3,461	804	23.2	17.3
Shipping and related device manufacturing	3,493	886	25.4	16.7
Railway transportation equipment manufacturing	965	186	19.3	16.7
Agriculture	243	52	21.4	16.5
Road transportation	1,317	228	17.3	16.1
Construction	1,476	206	14.0	15.2
Power, heat, gas, water production, and supply	591	82	13.9	13.5
Furniture manufacturing	8,241	1,371	16.6	12.0
Petrochemical industry	150	10	6.7	4.0
Chi-square test			1203.6	
P value			0	

Note: p_i: actual age-specific prevalence rate, p': standardized prevalence rate.

The influencing factors of UL-WMSDs were divided into individual, work type, and work organization factors. The univariate analysis results (Table 2) show that gender, age, length of service, educational level, smoking status, sports, and other individual-level factors were significantly associated with the occurrence of UL-WMSDs (P<0.05). The incidence of UL-WMSDs in women was higher than that in men. The risk of UL-WMSDs increased with the length of service and educational level. The risk of UL-WMSDs in smoking and physical exercise groups was significantly lower than in the control group. Maintaining the same posture at a high frequency, always making the same movement with the trunk, always pinching/grasping some objects/tools, wrist is in a bent posture for a prolonged time, and other factors such as work type correlated significantly with the occurrence of UL-WMSDs (P<0.05). Frequent overtime work, staff shortages, and doing the same job nearly every day are positively correlated with the occurrence of UL-WMSDs, and the difference is statistically significant (P<0.05).

TABLE 2. Univariate analysis of factors of upper-limb musculoskeletal disorders among occupational groups in key industries in China, 2018–2021.

Variable	Upper-limb musculoskeletal disorders			
	Number of workers	Case	Percentage (%)	*OR* (95% *CI*)
Individual risk factors				
Gender				
Men	49,079	11,050	22.5	1
Women	22,950	7,143	31.1	1.555 (1.502–1.611)*
Age (years)				
<25	7,909	1,858	23.5	1
25–	29,582	7,495	25.3	1.105 (1.043–1.171)*
35–	19,768	5,269	26.7	1.184 (1.114–1.258)*
45–	11,385	2,857	25.1	1.091 (1.020–1.167)*
55–	3,385	714	21.1	0.871 (0.790–0.960)*
Length of service (years)				
<2	19,138	4,143	21.6	1
2–	14,549	3,617	24.9	1.198 (1.138–1.260)*
4–	9,179	2,332	25.4	1.233 (1.163–1.307)*
6–	6,790	1,781	26.2	1.287 (1.207–1.372)*
8–	22,373	6,320	28.2	1.425 (1.362–1.491)*
Educational level				
Junior high school	21,365	4,810	22.5	1
Senior high school	26,632	6,586	24.7	1.131 (1.084–1.180)*
University degree	14,365	3,776	26.3	1.227 (1.169–1.289)*
Graduate degree	9,667	3,021	31.3	1.564 (1.483–1.651)*
Body mass index (BMI)				
<18.5	6,681	1,725	25.8	1
18.5–	48,323	12,284	25.4	0.979 (0.924–1.038)
25–	17,025	4,184	24.6	0.936 (0.877–0.999)
Smoking				
No	43,743	11,600	26.5	1
Occasionally	13,034	2,800	21.5	0.758 (0.723–0.795)*
Frequently	15,252	3,793	24.9	0.917 (0.879–0.957)*

TABLE 2. (Continued)

Variable	Upper-limb musculoskeletal disorders			
	Number of workers	Case	Percentage (%)	*OR* (95% *CI*)
Physical exercise				
No	21,619	5,877	27.2	1
Occasionally	38,073	9,443	24.8	0.883 (0.851–0.918)*
Frequently	12,337	2,873	23.3	0.813 (0.772–0.856)*
Workplace risk factor				
Standing often at work				
No	11,038	2,816	25.5	1
Yes	60,991	15,377	25.2	0.984 (0.940–1.031)
Sitting often at work				
No	30,850	7,792	25.3	1
Yes	41,179	10,401	25.3	1 (0.967–1.035)
Squatting or kneeling often at work				
No	41,776	9,828	23.5	1
Yes	30,253	8,365	27.7	1.242 (1.201–1.285)*
Lifting heavy loads (more than 5 kg)				
No	25,091	5,764	23.0	1
Yes	46,938	12,429	26.5	1.208 (1.165–1.252)*
Lifting heavy loads (more than 20 kg)				
No	38,885	9,189	23.6	1
Yes	33,144	9,004	27.2	1.205 (1.165–1.247)*
Exerting great force on the upper limbs or hands				
No	11,908	2,186	18.4	1
Yes	60,121	16,007	26.6	1.614 (1.535–1.696)*
Use of vibration tools at work				
No	43,855	10,087	23.0	1
Yes	28,174	8,106	28.8	1.352 (1.307–1.399)*
Maintaining the same posture at a high frequency				
No	13,728	1,927	14.0	1
Yes	58,301	16,266	27.9	2.370 (2.251–2.495)*
Trunk posture				
Trunk straight	24,051	4,441	18.5	1
Bending slightly at the trunk	38,398	10,502	27.4	1.662 (1.598–1.729)*
Bending heavily at the trunk	9,580	3,250	33.9	2.267 (2.149–2.391)*
Always turning around with the trunk				
No	25,512	5,327	20.9	1
Yes	46,517	12,866	27.7	1.449 (1.397–1.502)*
Always bending and twisting with the trunk				
No	40,670	8,313	20.4	1
Yes	31,359	9,880	31.5	1.790 (1.731–1.852)*
Always making the same movement with the trunk				
No	28,488	5,031	17.7	1
Yes	43,541	13,162	30.2	2.020 (1.947–2.096)*

TABLE 2. (Continued)

Variable	Upper-limb musculoskeletal disorders			
	Number of workers	Case	Percentage (%)	*OR* (95% *CI*)
Always bending the wrist up and down				
No	25,344	4,431	17.5	1
Yes	46,685	13,762	29.5	1.973 (1.899–2.049)*
Wrist is in a bent posture for a prolonged time				
No	40,455	7,503	18.5	1
Yes	31,574	10,690	33.9	2.248 (2.172–2.326)*
Wrist is often placed on the edge of hard and angular objects				
No	45,945	9,733	21.2	1
Yes	26,084	8,460	32.4	1.786 (1.726–1.848)*
Always pinching/grasping some objects/tools				
No	16,396	2,643	16.1	1
Yes	55,633	15,550	28.0	2.019 (1.929–2.113)*
Working above the shoulder level				
No	59,211	14,804	25.0	1
Yes	12,818	3,389	26.4	1.078 (1.032–1.126)*
Work organization factors				
Often working overtime	34,078	7,492	22.0	1
No	37,951	10,701	28.2	1.394 (1.347–1.442)*
Yes				
Abundant resting time				
No	38,303	12,579	32.8	1
Yes	33,726	5,614	16.6	0.408 (0.394–0.423)*
Deciding on an independent rest time				
No	57,741	15,346	26.6	1
Yes	14,288	2,847	19.9	0.687 (0.657–0.719)*
Staff shortage				
No	38,967	8,003	20.5	1
Yes	33,062	10,190	30.8	1.724 (1.666–1.783)*
Doing the same job nearly every day				
No	8,579	1,415	16.5	1
Yes	63,450	16,778	26.4	1.820 (1.715–1.932)*
Job rotation				
No	34,642	9,457	27.3	1
Yes	37,387	8,736	23.4	0.812 (0.785–0.840)*

Abbreviation: COR=Crude odds ratio; *CI*=confidence interval.
* *P*<0.05.

Abundant resting time, deciding on an independent rest time and job rotation are the protective factor of UL-WMSDs. The results of the multiple logistic regression showed that the influencing factors of UL-WMSDs were maintaining the same postures at a high frequency, use of vibration tools at work, working above shoulder level, length of service (in years), exerting great force on the upper limbs or hands, lifting of heavy loads (more than 20 kg) and job rotation, according to the odds ratio (*OR*). The last item, job rotation, is a protective factor (Table 3).

TABLE 3. Multivariate logistic regression model predicting the risk factors of upper-limb musculoskeletal disorders among occupational groups in key industries in China, 2018–2021.

Variable	Coefficient	Wald χ^2	a*OR*	95% *CI*	*P* value
Maintaining the same posture at a high frequency	0.270	418.798	1.310	1.277–1.345	0.000
Use of vibration tools at work	0.148	53.134	1.160	1.114–1.207	0.000
Working above the shoulder level	0.076	10.515	1.079	1.030–1.130	0.001
Length of service	0.071	117.284	1.073	1.060–1.087	0.000
Exerting great force on the upper limbs or hands	0.066	4.675	1.068	1.006–1.134	0.031
Lifting heavy loads (more than 20 kg)	0.056	7.430	1.058	1.016–1.102	0.006
Job rotation	−0.105	17.066	0.900	0.857–0.946	0.000

Note: North China: Beijing, Tianjin; East China: Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Jiangxi; Central China: Hubei; South China: Guangdong; Southwest China: Sichuan, Chongqing, Guizhou, Yunnan, Northwest China: Shanxi, Ningxia; Northeast China: Liaoning.
Abbreviation: a*OR*=adjusted odds ratio; *CI*=confidence interval.

DISCUSSION

This study was an occupational health risk assessment investigation established by the Chinese Center for Disease Control and Prevention from January 2018 to December 2023. It is the largest population survey on WMSDs in China so far. It aimed to include a large sample to conduct an epidemiological survey and research into the occurrence of UL-WMSDs in critical industries or occupational groups in different regions of China. This aim was to determine the occurrence and distribution characteristics of WMSDs in key sectors in China. Furthermore, we explored the epidemic rule and identified the influencing factors of WMSDs.

Moreover, our study provided big data to support the inclusion of WMSDs in crucial industries in China's List of Legal Occupational Diseases. The study published relevant reports in *China CDC Weekly* in 2020 and 2021, respectively (*3*–*4*). The data reported in this paper were those collected until 2021. Hence, they only described the occurrence of UL-WMSDs and analyzed the relevant influencing factors.

The survey results show that the standardized rate of UL-WMSDs in key industries or occupational groups in China was 22.5%. A survey (*5*) on musculoskeletal diseases related to work during the second industrial revolution in the 21st century in Europe shows a prevalence of upper limb musculoskeletal diseases between 4% and 26%, similar to our survey results. The survey found a significantly different incidence of WMSDs among different industries and showed that WMSDs were related to the work type and work organization factors, with prominent occupational characteristics. This study found that animal husbandry and biopharmaceutical product manufacturing had the highest upper limb musculoskeletal diseases among the industries, with an incidence of more than 35%. The survey found that the operation mode in the above two industries occurred during the assembly line operation, and workers' hands, wrists, and elbows needed quick and repetitive activity. At the end of each operation cycle, there was little or very short rest time. Research shows that (*6*) prolonged, repeated exertion may lead to local muscle fatigue and, if left unrecovered for a long time, causes musculoskeletal disorders easily. The risk factors of UL-WMSDs can be divided into individual-level, work type, and work organization factors. The results of this study showed that, in terms of individual-level factors, gender, age, length of service, educational level, smoking status, and sports were all related to the occurrence of UL-WMSDs ($P<0.05$). Of these, length of service remained a significant variable in univariate and multivariate logistic regression analyses. In terms of the work type factors, repetitive work in the same posture at a high frequency, use of vibration tools at work, working above shoulder level, exerting great force on the upper limbs or hands, lifting of heavy loads (more than 20 kg) are all risk factors of UL-WMSDs. A large number of scholarly articles have confirmed the above results. A population-based case-control study found (*7*) a dose-response relationship between the cumulative duration of work with highly elevated arms (positioned above shoulder level) and ruptures of the supraspinatus tendon.

The results of this study show that the risk of UL-WMSDs will increase when handling objects that weigh over 20 kg. Some studies have also confirmed (*8*) that the occurrence of UL-WMSDs is positively correlated with the weight of the object being carried (load mass). This may be related to manual handling without the use of auxiliary tools. The heavier the load of moving objects, the harder it is for workers to carry

them, resulting in increased hand pain. In terms of work organization factors, the results of this study show that job rotation is a protective factor of UL-WMSDs. Previous studies also support this view. A study showed that (*9*) the implementation of job rotation can help increase the variability of muscle activities, particularly in upper extreme muscles and can reduce the burden of occupational injury.

Although this study is a population survey with a large sample used to clarify the epidemiological characteristics and risk factors of UL-WMSDs in critical sectors or occupational groups in China, the following limitations still exist. First, the current study's design makes it difficult to determine the temporal relationship between the antecedents and consequences and infer the causal relationship between the risk factors and the occurrence of UL-WMSDs. Second, this study used questionnaires to obtain information about the respondents' illnesses in the past year. Since it is easy to forget the past, report and recall bias could have occurred.

In conclusion, the standardized incidence of UL-WMSDs in key industries or occupational groups in China is 22.5%. UL-WMSDs have recognized occupation-related characteristics, and their risk factors change with the length of service, type of work, work posture, work organization, and other factors. Given this, it is suggested to continue to carry out special epidemiological investigation and research on a large sample of the occupational population in key industries nationwideand establish a database of factors related to musculoskeletal disorders among occupational population in key industries in China, to provide extensive data support for listing UL-WMSDs to relevant regions in China's List of Legal Occupational Diseases.

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