Preplanned Studies

Prevalence and Risk Factors of Lower Extremity Musculoskeletal Disorders Among Occupational Groups in Key Industries — China, 2018–2023

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Summary

What is already known about this topic?

Lower extremity musculoskeletal diseases (LE-MSDs) have emerged as a significant contributor to the global disease economic burden and worker absenteeism, becoming a global public health concern. However, the epidemic characteristics of LE-MSDs among occupational populations in China are unknown.

What is added by this report?

This report finds that the LE-MSDs prevalence rate among key occupational groups in China is 17.7%, with the top 5 being toy manufacturing, medical personnel, automobile manufacturing, nonferrous metal smelting and rolling processing, and coal mining and washing.

What are the implications for public health practice?

This study investigated the occurrence of LE-MSDs in key industries in China and its possible risk factors to provide big data support for preventing and controlling such diseases in these industries.

Approximately 1.71 billion people worldwide suffer from musculoskeletal diseases (MSDs) (*1*), and this number is expected to increase in the coming decades. The prevention and control of MSDs have attracted global attention. With economic transformation, industrial upgrading, and rapid industrialization in China, new technologies, processes, and materials are widely used, leading to the emergence of new occupational hazards such as MSDs. The Healthy China Action (2019–2030) includes the prevention and control of MSDs caused by adverse ergonomic factors in occupational health protection actions. The National Health Commission of the People's Republic of China is studying the inclusion of MSDs in the Classification and Catalogue of Occupational Diseases and plans to include them in statutory occupational disease management. To provide a solid database for this policy's implementation, the Institute of Occupational Health and Poisoning Control of the China CDC conducted a nationwide risk assessment project from 2018 to 2023. This project focused on studying MSDs caused by adverse ergonomic factors, particularly addressing previous data gaps, such as the lack of comprehensive epidemiological data on the prevalence and risk factors of MSDs in occupational settings and the under-representation of lower extremity MSDs (LE-MSDs) in research. However, lower extremity MSDs (LE-MSDs, including hip/thigh, knee, and ankle/foot) have not received sufficient attention in MSD research and prevention. This may be due to several factors, including a historical focus on upper body MSDs, less recognition of the impact of LE-MSDs on the ability to work and the associated economic burden, and the complexity of diagnosing and attributing LE-MSDs to specific occupational hazards. The global disease burden survey reveals that LE-MSDs have become one of the leading causes of global disabilities (*2*). Therefore, this paper focuses on the distribution of LE-MSDs and related influencing factors in key industries or worker populations in China. This study found that the standardized prevalence rate of LE-MSDs in key industries or occupational groups in China is 17.7%. Individual, work type, and work organization factors may impact LE-MSDs. This study provides data support for China in formulating relevant preventive countermeasures and strategies for MSDs and revising occupational disease classifications and catalogues.

Data for this study were obtained from 7 regions in China: North, East, Central, South, Southwest, Northwest, and Northeast. These regions encompass 9

national economic industries: agriculture, forestry, animal husbandry, fishery, mining, manufacturing, electricity, heat, gas, and water production and supply; construction; wholesale and retail; transportation, warehousing, and postal services; residents' services, repairs, and other services; and health and social work.

This study used stratified random sampling to select representative industries closely related to work-related MSD (WMSD) occurrence from the above-mentioned areas. Samples were drawn according to the following principle: 1–2 large enterprises, 2–4 medium-sized enterprises, and 5–7 small enterprises (all enterprises with insufficient numbers were included). Subsequently, all workers who met the inclusion and exclusion criteria were selected as participants by stratified cluster sampling. Inclusion criteria were workers with >1 year of service. Exclusion criteria were congenital spinal deformity and non-work-related MSDs due to trauma, infectious diseases, and malignant tumors. This study was reviewed by the Medical Ethical Review Committee of Occupational Health and Poison Control at the Chinese Center for Disease Control and Prevention, and all participants provided informed consent.

In this survey, the "Ergonomic Evaluation and Analysis System of WMSDs" (*3*) developed by the Department of Occupational Protection and Ergonomics of the National Institute of Occupational Health and Poison Control of the China CDC was used to investigate the occurrence and influencing factors of WMSDs in key industries or among workers in different regions of China. The survey tool was a questionnaire built into this system, namely, the electronic questionnaire system of the Chinese version of the Musculoskeletal Disorders Questionnaire. This questionnaire was based on the Nordic Musculoskeletal Questionnaire (NMQ) and the Dutch Musculoskeletal Disorders Questionnaire (*4*). After appropriate modification, it has demonstrated good reliability and validity and can be used for occupational populations in China. The survey adopted a 1:N format; one investigator organized N respondents to scan the Quick Response(QR) code of the electronic questionnaire and answer the questions online. Upon completion, questionnaires were directly submitted and uploaded to a cloud database. After export, data were analyzed using SPSS 26.0 (version 26.0; Armonk, NY, USA). The prevalence of LE-MSDs in key industries in China is expressed by the age-standardized prevalence rate based on age composition data (18–60 years old) from the seventh national census. Univariate analysis of LE-MSDs used the χ^2 test, and multivariate analysis used unconditional logistic regression. This study adopted the US National Institute for 0ccupational Safety and Health(NIOSH) criteria (*3*) for LE-MSDs in the United States: discomfort symptoms such as hurt, pain, stiffness, burning, numbness, or tingling, and at the same time: 1) discomfort in the past year; 2) discomfort began after starting the current job; 3) no past accident or sudden injury (in the area of discomfort); and 4) discomfort occurring monthly or lasting more than 1 week was judged as an MSD.

By the end of 2023, 88,609 valid questionnaires were received. Table 1 shows that the standardized prevalence of LE-MSDs in key industries or workers in China was 17.7%, and there were statistically significant differences among industries (P<0.05). The 5 industries with the highest standardized prevalence rates were toy manufacturing (29.0%), medical personnel (25.5%), automobile manufacturing (23.2%), nonferrous metal smelting and rolling processing (22.5%), and coal mining and washing (20.9%).

Individual, work type, and work organization factors may affect LE-MSD prevalence. Univariate analysis (Table 2) identified statistically significant (P<0.05) factors, which were then included as independent variables in a multivariate logistic regression analysis. The results showed that repeatedly performing the same movements with the lower limbs and ankles [odds ratio (*OR*)=1.394, 95% confidence interval (*CI*): 1.325–1.467] was associated with the highest risk of LE-MSDs. Other risk factors included frequently standing at work, job rotation, working in the same postures at a high pace, repetitive trunk movements, staff shortages, frequent overtime work, trunk posture, frequent trunk bending and twisting, prolonged knee bending, frequent squatting or kneeling at work, and exerting significant force with the upper limbs or hands. Protective factors against LE-MSDs included physical exercise, year of investigation, stretching or changing leg posture, frequent sitting at work, and sufficient rest time. Further details are presented in Table 3.

DISCUSSION

Since 2018, the Institute of Occupational Health and Poisoning Control of the China Center for Disease Control and Prevention has organized provincial and municipal centers for disease control and prevention

TABLE 1. Incidence of lower extremity musculoskeletal disorders in key industries or occupational groups in China, 2018–2023. (*n*=88,609).

Industry/working group	Number	Lower extremity musculoskeletal disorders			
		n	pi	p'	95% *CI*
Total	88,609	16,387	18.5	17.7	0.182–0.187
Automobile manufacturing	21,759	5,317	24.4	23.2	0.239–0.250
Computer, communication industry, and other electronic equipment manufacturing	10,638	1,540	14.5	15.4	0.138–0.151
Furniture manufacturing	9,004	1,242	13.8	12.4	0.131–0.145
Footwear industry	7,100	1,036	14.6	15.2	0.138–0.154
Medical staff	7,011	1,899	27.1	25.5	0.260–0.281
Ferrous metal smelting and rolling	3,494	620	17.7	16.3	0.165–0.190
Electrical machinery and equipment manufacturing industry	3,434	343	10.0	9.7	0.090–0.110
Shipping and related device manufacturing	3,431	723	21.1	19.6	0.197–0.224
Coal mining and washing	3,356	735	21.9	20.9	0.205–0.233
Metal products industry	3,195	374	11.7	10.6	0.106–0.128
Nonferrous metal smelting and rolling processing industry	2,312	596	25.8	22.5	0.240–0.276
Road transportation	2,296	254	11.1	14.3	0.098–0.123
Biopharmaceutical product manufacturing	1,738	233	13.4	13.5	0.118–0.150
Railway transportation equipment manufacturing	1,674	220	13.1	12.3	0.115–0.148
Construction	1,434	137	9.6	10.2	0.080–0.111
Civil aviation flight attendants	1,341	270	20.1	18	0.180–0.223
Non-ferrous metal mining and dressing industry	1,225	171	14.0	13.7	0.120–0.159
Comprehensive retail industry	1,086	156	14.4	13.8	0.123–0.165
Food manufacturing industry	828	137	16.5	15.7	0.140–0.191
Automobile repair and maintenance	777	109	14.0	14	0.116–0.165
Toy manufacturing	325	79	24.3	29	0.196–0.290
Animal husbandry	245	48	20.3	20.3	0.146–0.246
Agriculture	239	76	31.8	17.6	0.259–0.377
Cement, lime, and gypsum manufacturing	194	19	9.8	20.4	0.056–0.140
Petrochemical industry	150	8	5.3	4.5	0.017–0.090
Chemical raw materials and chemical products manufacturing industry	95	8	8.4	8.4	0.027–0.141
Handling and warehousing industry	92	7	7.6	6.3	0.021–0.131
Power, heat, gas, water production, and supply	86	20	23.3	18.3	0.141–0.324
Packaging, decoration and other printing industries	50	10	8.1	7.6	0.085–0.315
Chi-square test			1,899.9		
P			*P*<0.001		

Note: pi: actual crude prevalence rate, p': standardised prevalence rate.
Abbreviation: *CI*=confidence interval.

and occupational prevention institutes to conduct occupational health risk assessments of MSDs caused by adverse ergonomic factors in key industries and operations in different regions of China. This project was reported in China Weekly in 2020, 2021, and 2022 (*5*–*7*). The data used in this paper are current to the end of 2023, describe only the occurrence of LE-MSDs, and analyze the related influencing factors.

This study found that the standardized rate of LE-MSDs in key industries or workers in China was 17.7%. In 2015, the European Agency for Safety and Health (EU-OSHA) (*8*) conducted an MSD survey across 28 countries in the European Union using the NMQ. This survey reported a 29% rate of self-reported LE-MSDs. It also showed that the occurrence of LE-MSDs varied across industries, suggesting that

TABLE 2. Univariate analysis of lower extremity musculoskeletal disorders among occupational groups in key industries in China, 2018–2023.

Variables	lower extremity musculoskeletal disorders			
	Number of workers	Case	Percentage (%)	*COR* (95% *CI*)
Individual risk factors				
Gender				
Men	59,989	11,287	18.8	1
Women	28,620	5,100	17.8	0.936 (0.902, 0.970)*
Age (years)				
<25	14,349	2,854	19.90	1
25–34	34,336	6,845	19.90	1.003 (0.955, 1.053)
35–44	22,172	3,827	17.30	0. 840 (0.796, 0.887)*
45–54	13,417	2,180	16.20	0.781 (0.735, 0.831)*
≥55	4,335	681	15.70	0.751 (0.685, 0.823)*
Working age (years)				
<2	22,029	3,534	16.00	1
2–3	17,155	3,204	18.70	1.202 (1.140, 1.267)*
4–5	11,268	2,041	18.10	1.158 (1.090, 1.229)*
6–7	8,414	1,609	19.10	1.237 (1.159, 1.321)*
≥8	29,743	5,999	20.20	1.322 (1.263, 1.384)*
Education level				
Junior high school	27,912	4,067	14.60	1
Senior high school	32,301	6,422	19.90	1.455 (1.394, 1.519)*
University degree	27,157	5,740	21.10	1.571 (1.503, 1.642)*
Graduate degree	1,239	158	12.80	0.857 (0.723, 1.016)
Body mass index (BMI)				
<18.5	7,219	1,426	19.80	1
18.5–24	59,030	10,627	18.00	0.892 (0.839, 0.949)*
≥25	22,360	4,334	19.40	0.977 (0.914, 1.044)
Smoking				
No	55,882	9,981	17.90	1
Occasionally	15,446	2,741	17.70	0.992 (0.947, 1.040)
Frequently	17,281	3,665	21.20	1.238 (1.186, 1.291)*
Physical exercise				
No	27,057	5,400	20.00	1
Occasionally	46,152	8,440	18.30	0.898 (0.864, 0.932)*
Frequently	15,400	2,547	16.50	0.795 (0.755, 0.837)*
Workplace risk factor				
Standing often at work				
No	14,322	1,468	10.20	1
Yes	74,287	14,919	20.10	2.200 (2.079, 2.239)*
Sitting often at work				
No	37,986	8,212	21.60	1
Yes	50,623	8,175	16.10	0.698 (0.675, 0.722)*
Squatting or kneeling often at work				

Continued

Variables	lower extremity musculoskeletal disorders			
	Number of workers	Case	Percentage (%)	*COR* (95% *CI*)
No	53,516	8,064	15.10	1
Yes	35,093	8,323	23.70	1.752 (1.694, 1.813)*
Lift heavy loads (more than 5 kg)				
No	32,171	4,436	13.80	1
Yes	56,438	11,951	21.20	1.680 (1.618, 1.744)*
Lift heavy loads (more than 20 kg)				
No	48,825	7,540	15.40	1
Yes	39,784	8,847	22.20	1.566 (1.513, 1.620)*
Exerting great force on upper limbs or hands				
No	15,302	1,610	10.50	1
Yes	73,307	14,777	20.20	2.147 (2.033, 2.268)*
Use vibration tools at work				
No	55,729	8,639	15.50	1
Yes	32,880	7,748	23.60	1.680 (1.624, 1.739)*
Working in the same postures at a high pace				
No	18,294	1,828	10.00	1
Yes	70,315	14,559	20.70	2.352 (2.234, 2.477)*
Trunk posture				
Trunk straight	30,837	4,158	13.50	1
Bend slightly with your trunk	46,971	8,991	19.10	1.519 (1.459, 1.581)*
Bend heavily with your trunk	10,801	3,238	30.00	2.747 (2.606, 2.895)*
Always turn around with your trunk				
No	33,138	3,951	11.90	1
Yes	55471	12,436	22.40	2.135 (2.054, 2.219)*
Always bend and twist with your trunk				
No	51,769	6,915	13.40	1
Yes	36,840	9,472	25.70	2.245 (2.169, 2.324)*
Always make the same movements with your trunk				
No	44,006	5,262	12.00	1
Yes	44,603	11,125	24.90	2.447 (2.360, 2.536)*
Wrists in bent posture for a prolonged time				
No	37,186	5,150	13.80	1
Yes	51,423	11,237	21.90	1.739 (1.678, 1.803)*
Stretch or change leg posture				
No	20,031	3,885	19.40	1
Yes	68,578	12,502	18.20	0.927 (0.890, 0.964)*
Keep your knees bent for a prolonged time				
No	60,893	9,627	15.80	1
Yes	27,716	6,760	24.40	1.718 (1.659, 1.779)*
Lower limbs and ankles often do the same movements repeatedly				
No	54,101	7,448	13.80	1
Yes	34,508	8,939	25.90	2.190 (2.116, 2.266)*

Continued

Variables	lower extremity musculoskeletal disorders			
	Number of workers	Case	Percentage (%)	*COR* (95% *CI*)
Work organization factors				
Often work overtime	45,009	6,400	14.20	1
No	43,600	9,987	22.90	1.792 (1.731, 1.856)*
Yes				
Abundant resting time				
No	43,384	11,274	26.00	1
Yes	45,225	5,113	11.30	0.363 (0.350, 0.376)*
Decide the rest time independently				
No	69,214	13,757	19.90	1
Yes	19,395	2,630	13.60	0.632 (0.604, 0.662)*
Staff shortage				
No	50,002	6,925	13.80	1
Yes	38,607	9,462	24.50	2.020 (1.951, 2.090)*
Do the same job almost every day				
No	10,530	1,278	12.10	1
Yes	78,079	15,109	19.40	1.737 (1.634, 1.847)*
Job rotation				
No	37,537	5,693	15.20	1
Yes	51,072	10,694	20.90	1.481 (1.430, 1.535)*

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

working environments and methods differ. This finding is consistent with the results of the present survey in China.

This study showed that prolonged standing and frequent, repetitive lower limb and ankle movements are high-risk factors for LE-MSDs. Research shows that prolonged standing increases venous pressure in the lower limbs, which may lead to obstructed blood return and venous hypertension (*9*). Persistent venous hypertension not only increases muscle load but also causes poor circulation and insufficient oxygen supply, ultimately leading to muscle fatigue and injury. A laboratory review of prolonged standing and MSDs indicated that standing for 40 minutes can be regarded as the exposure limit for prolonged standing (*10*). In addition to work type, this study found that individual and work organization factors cannot be ignored in relation to LE-MSDs. Studies show that obesity significantly increases the burden on the lower limb musculoskeletal system (*11*). Excess weight places more stress on joints and bones, which can easily cause inflammation, cartilage wear, and muscle injury, particularly in the weight-bearing knee and hip joints. Obesity accelerates tissue degeneration and injury. A survey of female hospital cleaners working under two different organizational models found that the group with more beneficial psychosocial factors (e.g., sufficient staffing, adequate rest time, and fewer shifts) had better musculoskeletal health (*12*). A cross-sectional survey of European working conditions also indicated that good work organization is vital to preventing LE-MSDs (*13*). This aligns with our findings. The following factors may explain this situation. First, frequent overtime and insufficient staffing may lead to prolonged work under high pressure. This continuous physical labor increases the burden on the lower limbs, increasing the risk of LE-MSDs. Additionally, performing the same job almost daily means a lack of variety and restricted movement, leading to the overuse of specific muscle groups and increased musculoskeletal stress due to fixed postures. Conversely, adequate rest time allows employees to recover physically and relieve muscle tension. Short rests promote blood circulation, reduce muscle fatigue, and help prevent MSDs. Self-determination of rest time provides employees with greater flexibility, enabling them to adjust their work rhythm to their physical needs, positively affecting work conditions

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

Variable	Coefficient	Wald χ^2	*AOR*	95% *CI*	*P*
Lower limbs and ankles often do the same movements repeatedly	0.332	165.193	1.394	1.325, 1.467	0.000
Standing often at work	0.314	63.367	1.368	1.267, 1.478	0.000
Job rotation	0.303	160.727	1.353	1.292, 1.418	0.000
Working in the same postures at a high pace	0.269	42.494	1.309	1.207, 1.419	0.000
Always make the same movements with your trunk	0.266	81.385	1.305	1.232, 1.383	0.000
Staff shortage	0.242	101.516	1.274	1.215, 1.335	0.000
Often work overtime	0.179	57.432	1.196	1.142, 1.253	0.000
Trunk posture	0.13	51.972	1.139	1.099, 1.180	0.000
Always bend and twist with your trunk	0.122	19.711	1.13	1.070, 1.192	0.000
Keep your knees bent for a prolonged time	0.11	17.996	1.117	1.061, 1.175	0.000
Squatting or kneeling often at work	0.107	17.31	1.113	1.058, 1.171	0.000
Exerting great force on upper limbs or hands	0.106	6.739	1.112	1.026, 1.204	0.009
Use vibration tools at work	0.093	14.345	1.097	1.046, 1.151	0.000
Education level	0.087	36.535	1.091	1.061, 1.123	0.000
Body mass index (BMI)	0.077	13.989	1.08	1.037, 1.124	0.000
Working age (years)	0.06	66.734	1.062	1.047, 1.077	0.000
Physical exercise	−0.056	11.116	0.945	0.915, 0.977	0.001
Investigation year	−0.104	195.421	0.901	0.888, 0.914	0.000
Stretch or change leg posture	−0.122	20.834	0.886	0.840, 0.933	0.000
Sitting often at work	−0.258	112.274	0.773	0.737, 0.810	0.000
Abundant resting time	−0.548	465.856	0.578	0.550, 0.608	0.000
Always make the same movements with your trunk	−2.739	1129.345	0.065	0.055, 0.076	0.000

Abbreviation: *AOR*=adjusted odds ratio; *CI*=confidence interval.

and MSD prevention. Implementing a shift system helps break the monotony of work. Varying work hours and task assignments reduce the continuous load on specific muscle groups, thereby reducing the risk of MSDs. Therefore, to protect employee health, companies should consider arranging reasonable working hours, providing sufficient rest opportunities, and implementing shift systems to mitigate MSD risks for employees engaged in the same job long-term.

This study has some limitations. First, as a cross-sectional study, it is subject to recall bias. The study relies on participants' memories of work-related musculoskeletal diseases in the past year, which may be inaccurate. Workers with mild or habitual pain may forget some medical histories and individual cognitive differences can exacerbate inconsistencies in memory quality. Second, causality is uncertain. Although the study identifies related risk factors, the cross-sectional design cannot determine the sequence of variables. Therefore, it is unclear whether working conditions cause the disease or if conditions change after illness onset, which hinders the formulation of effective prevention strategies. In summary, the standardized prevalence rate of LE-MSDs in key industries and occupational groups in China was 17.7%. The five industries or occupational groups with the highest prevalence rates of LE-MSDs are toy manufacturing, medical personnel, automobile manufacturing, nonferrous metal smelting and rolling processing, and coal mining and washing, demonstrating clear occupational characteristics. In addition to occupational factors, such as prolonged standing, personal and work organization factors must also be considered. Therefore, it is necessary to strengthen the dissemination and education of ergonomics knowledge for professionals. These efforts could include improving workbench design, implementing regular rest and activity breaks, and creating personalized exercise prescriptions tailored to the specific needs of the occupational population to reduce the impact of

LE-MSDs in China.

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