Vital Surveillances

Surveillance of Noise Exposure Level in the Manufacturing Industry — China, 2020

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ABSTRACT

Introduction: Occupational noise exposure is a widespread issue in the manufacturing industry in China. Since 2019, the National Surveillance System for Occupational Hazards in the workplace was established to understand different occupational hazards, especially occupational noise, in workplaces in China.

Methods: Both environmental and individual noise exposure levels were measured for 19,378 enterprises according to the *Work Plan for Surveillance of Occupational Hazards in the Workplace (2020)* issued by National Health Commission of the People's Republic of China. Median and interquartile range (IQR) were calculated to describe the distribution of the noise exposure level by industry classification, enterprise-scale, and ownership type of the enterprise.

Results: Overall, 25.14% of the individual noise exposure samples exceeded the Chinese national standard among the selected enterprises. The overall median of environmental noise exposure level was 82.8 dB(A) in selected enterprises, while the median of individual noise exposure level was 81.3 dB(A). The individual noise exposure level in the manufacture of metal products, manufacture of motor vehicles, mini-sized enterprises, collective enterprises and private enterprises was relatively high.

Conclusion: Occupational noise is still one of the occupational hazards that cannot be ignored in the manufacturing industry, especially in mini-sized and private enterprises. The risk of noise exposure in the target industry is still high and will pose a threat to the health of workers.

INTRODUCTION

Noise has been one of the most prevalent occupational hazards in many industries both in China and worldwide, which affects more than 10 million Chinese workers' health (*1*–*2*). With an annual growth of incidence of 24.2% from 2014, occupational noise-induced deafness has been the second leading occupational disease after pneumoconiosis in China (*3*). Since China's reform and opening-up, China's manufacturing industry has developed rapidly. In 2018, the number of enterprises exceeded 3 million, accounting for 15% of the total number of enterprises, with more than 100 million workers (*4*). Meanwhile, 67.56% of the diagnosed cases of occupational otolaryngological and stomatological diseases in China were from the manufacturing industry in 2020, which was reported from the National Surveillance System of Key Occupational Diseases. Studies reported that the noise exposure level in many workplaces exceeded 85 dB(A) among several manufacturing industries such as the wood furniture manufacturing industry, the transportation equipment manufacturing industry, and the automotive industry (*3*,*5*–*6*). Therefore, it is necessary to understand the noise exposure level in the workplace in the overall manufacturing industry from different dimensions and provide evidence for measures to reduce the noise exposure level and protect workers' health.

METHODS

In order to estimate the noise exposure level among the overall manufacturing industry on a national scale, 19,378 enterprises were selected from the database of National Surveillance System for Occupational Hazards in the workplace in 2020. The surveillance was conducted according to the *Work Plan for Surveillance of Occupational Hazards in the Workplace (2020)* issued by the National Health Commission of the People's Republic of China. Based on the plan's requirement, the average number of enterprises included in the surveillance in each county should not be less than 20, and a minimum total number of 55,890 enterprises should be monitored. Furthermore, all the enterprises included in the surveillance should be exposed to major occupational hazards selected

according to the epidemiological trends of occupational disease in China. The surveillance was conducted mostly by Occupational Disease Prevention and Control Institutes at the county level and occupational health technical service institutions. Quality control of the surveillance was conducted by provincial and municipal Occupational Disease Prevention and Control Institutes. The selected enterprises in this study were from 31 provincial-level administrative divisions (PLADs) and the Xinjiang Production and Construction Corps in China and were categorized according to their industrial classification, enterprise-scale, ownership type of the enterprise (*7*–*9*).

Both environmental and individual noise exposure levels were measured for each enterprise, the specific measurement guidelines were as follows: 1) at least 20 noise exposure areas should be measured in the workplace in large and medium-sized enterprises, and all of the noise exposure areas should be measured in the workplace in small and mini-sized enterprises; 2) the level of environmental noise onsite should be measured in each noise exposure area, and individual noise exposure measurements should be conducted for at least four operating posts in each enterprise; individual noise exposure measurements should be conducted for all operating posts if operating posts comprise less than four units; and 3) the sampling method and noise measure method for both environmental and individual noise exposure were determined according to the *Measurement of Physical Agents in the Workplace Part 8: Noise (GBZ/T 189.8–2007)*.

Statistical analysis was performed using SPSS (version 22.0, SPSS Inc, Chicago, IL, USA). The median and interquartile range (IQR) were calculated to describe the distribution of the noise exposure by industry classification, enterprise-scale, and ownership type of the enterprise. Kruskal-Wallis H test was used to compare noise exposure levels among different dimensions. The significance level of tests was $P<0.05$.

RESULTS

In this study, 19,378 enterprises from 10 major divisions of the manufacturing industry were included, and more than 530,000 workers were found exposed to occupational noise. As shown in Table 1, a total number of 111,858 environmental noise samples and 97,419 individual noise samples were detected. Overall, 25.14% of the individual noise exposure samples exceeded the Chinese national standard among the selected enterprises. The proportions of individual noise exposure levels equal to or above 85 dB(A) were much higher in the manufacturing of other non-metallic mineral products, which was 32.08%.

TABLE 1. Distribution of noise exposure levels among the manufacturing industry in different divisions — China, 2020.

Division*	Total number of enterprises	Total number of workers	Environmental noise exposure level [dB(A)]		Individual noise exposure level $L_{Ex,8h}/L_{Ex,40h}$† [dB(A)]		The proportion of individual noise exposure levels ≥85 dB(A) (%)
			Number of samples	Median (*IQR*)	Number of samples	Median (*IQR*)	
Manufacture of furniture	2,430	45,826	15,750	83.2 (80.2–86.5)	13,955	81.7 (77.4–84.8)	24.01
Printing and reproduction of recorded media	2,148	39,730	9,457	81.1 (78.0–83.8)	9,022	80.5 (76.3–83.4)	15.21
Manufacture of coke and refined petroleum products	359	27,552	3,470	82.9 (78.8–87.1)	2,196	78.3 (73.8–82.0)	9.39
Manufacture of chemicals and chemical products	1,401	40,121	8,354	80.1 (75.9–83.5)	6,439	77.4 (72.7–81.0)	7.59
Manufacture of other non-metallic mineral products	8,228	166,938	41,471	83.8 (80.3–88.9)	36,066	82.0 (77.3–86.9)	32.08
Casting of iron and steel	808	44,022	6,821	82.6 (78.7–86.8)	5,615	80.5 (76.4–84.2)	21.52
Casting of non-ferrous metals	1,001	55,640	7,733	82.2 (78.6–85.8)	6,202	80.5 (76.3–84.2)	20.39
Manufacture of metal products	1,368	35,715	7,688	83.2 (80.2–87.1)	7,224	82.2 (78.8–85.9)	29.01
Manufacture of motor vehicles	1,533	70,246	10,278	82.8 (79.7–86.7)	9,917	82.2 (78.7–85.6)	27.76
Manufacture of electrical equipment	102	7,928	836	82.4 (79.8–85.5)	783	81.8 (78.4–84.9)	24.58
Total	19,378	533,718	111,858	82.8 (79.3–87.0)	97,419	81.3 (76.9–85.0)	25.14

* $P<0.001$.

† $L_{Ex,8h}$: Normalization of equivalent continuous A-weighted sound pressure level to a nominal 8 hours working day. $L_{Ex,40h}$: Normalization of equivalent continuous A-weighted sound pressure level to a nominal 40 hours working week.

The surveillance results showed that all the medians of both environmental and individual noise exposure levels were below 85 dB(A). The overall median of environmental noise exposure level was 82.8 dB(A) in selected enterprises, while the median of individual noise exposure level was 81.3 dB(A). The medians of individual noise exposure levels in the categories of manufacturing of metal products, manufacturing of motor vehicles, and manufacturing of other non-metallic mineral products were higher compared to other divisions, and their upper quartiles showed that more than 25% of the operating posts were exposed to a noise level of 85 dB(A). The occupational noise exposure level was relatively high in the workplace among divisions of manufacturing of other non-metallic mineral products, manufacturing of furniture, and manufacturing of metal products, as shown by the median and their IQR, which were 83.8 (80.3–88.9), 83.2 (80.2–86.5), and 83.2 (80.2–87.1), respectively. The difference between the medians of environmental and individual noise exposure level in the manufacture of coke and refined petroleum products was 4.6 dB(A) (H=697.894, P<0.001), which was larger compared to other divisions.

As presented in Table 2, the proportions of individual noise exposure levels equal to or exceeding 85 dB(A) increased with the decline of the enterprise-scale. The mdian of individual noise exposure levels in mini-sized enterprises was the highest when compared to the other three enterprise scales (Table 2). The difference between the medians of environmental and individual noise exposure levels was 2.2 dB(A) in both the large and medium enterprise-scales, which were bigger than those in small and mini-sized [1.3, 1.5 dB(A)]. Table 2 also presents the distribution of the noise exposure states among the manufacturing enterprises in different ownership types. The proportions of individual noise exposure levels equal to

TABLE 2. Distribution of noise exposure levels among the manufacturing industry in different enterprise-scale and ownership type — China, 2020.

Item	Total number of enterprises	Total number of workers	Environmental noise exposure level [dB(A)]		Individual noise exposure level $L_{Ex,8h}$/$L_{Ex,40h}$ * [dB(A)]		The proportion of individual noise exposure level ≥85 dB(A) (%)
			Number of samples	Median (*IQR*)	Number of samples	Median (*IQR*)	
Enterprise-scale							
Large	458	76,923	6,291	83.3 (80.1–87.2)	4,884	81.1 (76.6–84.5)	22.07
Medium	1,878	169,139	20,556	83.1 (79.7–87.2)	17,277	80.9 (76.1–84.6)	23.13
Small	9,926	236,325	59,901	82.5 (79.1–86.5)	52,774	81.2 (76.9–84.8)	24.00
Mini-sized	7,116	51,331	25,110	83.2 (79.3–88.1)	22,484	81.7 (77.4–86.2)	30.11
P-value				<0.001		<0.001	
Ownership type							
State-owned	683	42,526	6,405	83.4 (80.1–87.6)	4,677	80.6 (76.9–84.1)	19.53
Collective	120	1,784	461	83.0 (79.8–86.2)	434	81.6 (78.1–84.3)	20.97
Joint-equity cooperative enterprises	221	9,246	1,425	83.0 (79.2–87.2)	1,196	81.6 (77.3–85.1)	25.42
Joint-operate	31	2,285	205	81.0 (78.4–84.7)	187	80.0 (76.0–84.1)	17.65
Private	6,421	114,065	29,957	83.0 (79.3–87.5)	25,687	81.4 (77.2–85.6)	27.91
Incorporated company	527	33,265	3,995	82.2 (78.5–86.0)	3,335	81.0 (76.8–84.3)	21.71
Limited liability company	10,062	275,998	60,573	82.8 (79.3–86.7)	54,075	81.3 (76.7–84.9)	24.70
Hong Kong, Macau, and Taiwan-invested enterprises	364	19,447	2,931	82.3 (79.1–86.2)	2,709	81.0 (75.9–84.3)	22.55
Foreign	476	26,638	3,625	82.3 (78.9–85.8)	3,167	81.1 (76.9–84.5)	22.99
Others	473	8,464	2,281	83.1 (79.3–87.6)	1,952	81.7 (77.1–85.8)	28.54
P-value				<0.001		<0.001	
Total	19,378	533,718	111,858	82.8 (79.3–87.0)	97,419	81.3 (76.9–85.0)	25.14

* $L_{Ex,8h}$: Normalization of equivalent continuous A-weighted sound pressure level to a nominal 8 hours working day. $L_{Ex,40h}$: Normalization of equivalent continuous A-weighted sound pressure level to a nominal 40 hours working week.

or exceeding 85 dB(A) were the highest in private and joint-equity cooperative enterprises. Incorporated enterprises were found to have the lowest occupational noise exposure risk, as shown by the medians of both environmental and individual noise exposure levels.

Conclusions and Comment

Surveillance of occupational hazards in the workplace has been carried out by the Chinese government since 2019. Occupational noise was selected as one of the major hazards in the surveillance, and more than a quarter of enterprises were from the manufacturing industry. The proportion of individual noise exposure levels equal to or exceeding 85 dB(A) was still high in the manufacturing industry. The medians of environmental noise exposure levels of all industries exceeded 80 dB(A), and the same was true of the individual noise exposure levels in eight industries except the manufacture of petroleum coke and other refined petroleum products. Based on the *Classification of Occupational Hazards at Workplaces Part 4: Occupational Exposure to Noise* (GBZ/T 229.4–2012), more than 50% of operating posts in those 8 divisions could be classified as having exposure to noise.

According to the surveillance results, the median of individual noise exposure levels was 82.2 dB(A), both in the manufacture of metal products and manufacture of motor vehicles, which were higher than the other divisions. However, as shown from the National Surveillance System of Key Occupational Diseases, the incidence of occupational noise deafness among the manufacture of metal products was much higher than that of the manufacture of motor vehicles in China. This may be due to the relatively high proportion of large and medium enterprises in the manufacture of motor vehicles, with better occupation health management and stronger self-protective awareness of workers (*4*). As for the manufacture of metal products, this category mostly consisted of small and mini-sized enterprises. The poor sense of self-protection results in serious hearing loss of workers in this industry. In addition, it is worth noting that there are methylbenzene, xylene, ethylbenzene, and other ototoxic substances that exist in the other three industries with lower noise exposure level. Another study showed that combined exposure of ototoxic substances and noise was more likely to cause hearing loss than noise exposure at the same exposure level (*10*).

The analysis of the noise exposure levels among different enterprise-scales shows that the noise hazard of small and mini-sized enterprises was more serious than that of large and medium enterprises. This phenomenon was mainly due to the insufficient investment in noise control and lower technical levels among small and mini-sized enterprises (*11*). Meanwhile, more than 80% of enterprises in China were small and mini-sized enterprises, so it is urgent to increase investment in the occupational disease prevention of small and mini-sized enterprises (*4*). Furthermore, the individual noise exposure levels of private enterprises were about 1 dB(A) higher than that of state-owned enterprises, which was mainly related to the decreased investment in occupational disease prevention among private enterprises.

This is the first comprehensive report presenting noise exposure levels in manufacturing industry in China based on different divisions, enterprise-scales, and ownerships based on National Surveillance for Occupational Hazards in the workplace in 2020. The risk of noise exposure in the target industry is still high and will threaten the health of a large number of the worker population. The detailed insight of the noise exposure will provide the government with evidence to improve the occupational health management and develop special governance measures in the target enterprises. Meanwhile, the data will also be used for the reversions of regulations related to occupational health and the implementation of national or local projects of occupational disease prevention and control. The limitation of this study is that we did not acquire the information of workers' occupational health during the surveillance. We will improve the method in the future study.

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