Epidemiological Characteristics of Occupational Cancers Reported — China, 2006–2020

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ABSTRACT

Introduction: Occupational cancers are a major threat to workers’ health in China. The latest version of the Classification and Catalogue of the Occupational Diseases includes 11 occupational cancers. This study analyzed the epidemiological characteristics of occupational cancers in China reported to the National Occupational Disease Reporting System during 2006–2020.

Methods: Occupational cancers reported during 2016–2020 were obtained from the National Occupational Disease Reporting System. Epidemiological characteristics were analyzed by year, region, industry, gender, age at diagnosis, and exposure duration to occupational hazards.

Results: Overall, a total of 1,116 cases of occupational cancers were reported between 2006 and 2020. The main types reported were leukemia caused by benzene exposure (511, 45.79%), lung cancer caused by coke oven exhaust exposure (266, 23.84%), and lung cancer and mesothelioma caused by asbestos exposure (226, 20.25%). There were 6 provincial-level administrative divisions (PLADs) that had reported over 50 new cases in the last 15 years. Most cases (913, 81.18%) were distributed in the manufacturing industry. There were 870 (77.96%) male cases and 246 (22.04%) female cases. The average age at diagnosis of all reported cases was 51.91±15.85 years, and the median exposure duration to occupational hazards was 12 (5.29–23.25) years.

Conclusions: There is a large discrepancy between the high morbidity of occupational cancers and a low number of cases diagnosed and reported cases. Occupational cancers in China may be underestimated, and comprehensive measures should be taken to improve the diagnosis and reporting of occupational cancers.

Occupational cancers are specific cancers suffered by workers after long-term exposure to carcinogenic factors in the working environment after a long latent period (1). The International Agency for Research on Cancer (IARC) has identified 40 carcinogens with relevant occupational exposure conditions (2). Approximately 2%–8% of all cancers were estimated to be caused by occupational exposures to carcinogens (3). In China, with the rapid development of industries, occupational cancers due to carcinogens in the workplace have become a major threat to workers’ health. A total of 11 occupational cancers were included in the latest version of “Classification and Catalogue of Occupational Diseases” (4) published in 2013, including: 1) lung cancer and mesothelioma caused by asbestos; 2) bladder cancer caused by benzidine; 3) leukemia caused by benzene; 4) lung cancer caused by chloromethyl ether and dichloromethyl ether; 5) lung cancer and skin cancer caused by arsenic and its compounds; 6) hepatic angiosarcoma caused by vinyl chloride; 7) lung cancer caused by coke oven emissions; 8) lung cancer caused by hexavalent chromium compounds; 9) lung cancer and pleural mesothelioma caused by erionite; 10) skin cancer caused by coal tar, coal tar pitch and petroleum pitch; and 11) bladder cancer caused by β-naphthylamine.

Since 2006, occupational diseases, including occupational cancers, have been reported directly online to the National Occupational Disease Reporting System by occupational disease diagnosis institutions. The total number of occupational cancers reported each year is published annually by the National Health Statistical Bulletin. To better understand the prevalence of occupational cancers in China, we abstracted the case-based data from the system between 2006 and 2020, and analyzed the epidemiological characteristics of occupational cancers in China.

METHODS

Cases of occupational cancers reported between January 1, 2006 and December 31, 2020 were obtained from the National Occupational Disease
Reporting System. The system is a network-based reporting system that includes all occupational disease diagnostic institutions in the mainland of China. To ensure the integrity and accuracy of the data, all data reported will be reviewed at county, city, and provincial levels. Descriptive analysis was conducted by year, region, disease type, industry, gender, the average age at diagnosis and exposure duration to occupational hazards. Categorical variables were described using frequencies and constituent ratios, and numerical variables were described using mean and standard deviation or median and interquartile range. Statistical analysis was carried out in SPSS (version 26.0, SPSS Inc, Chicago, IL, USA).

**RESULTS**

A total of 1,116 cases were reported between 2006 and 2020, and the cases reported annually were shown in Figure 1. As shown in Table 1, the three main types of reported cases were leukemia caused by benzene, lung cancers caused by coke oven exhaust, and lung cancer and mesothelioma caused by asbestos, with the numbers of reported cases being 511 (45.79%), 266 (23.84%), and 226 (20.25%), respectively. There were 6 types of occupational cancers (lung cancer caused by hexavalent chromium compounds; bladder cancer caused by benzidine; lung cancer and skin cancer caused by arsenic and its compounds; lung cancer caused by chloromethyl ether and dichloromethyl ether; skin cancer caused by coal tar; coal tar pitch, petroleum pitch, and bladder cancer caused by β-naphthylamine) with less than 50 reported cases. There were 2 types of occupational cancers (hepatic angiosarcoma caused by vinyl chloride, lung cancer and pleural mesothelioma caused by erionite) for which no cases were reported.

There were 6 provincial-level administrative divisions (PLADs) with reported cases above 50: Guangdong Province (335, 30.02%), Shandong Province (135, 12.1%), Liaoning Province (122, 10.93%), Hubei Province (93, 8.33%), Beijing Municipality (86, 7.71%), and Jiangsu Province (68, 6.09%).

![FIGURE 1. Reported cases of occupational cancers in China, 2006–2020.](image)

**TABLE 1. Occupational cancer cases reported by disease type, 2006–2020.**

| Disease type                                                      | Number of cases | Proportion (%) |
|------------------------------------------------------------------|-----------------|----------------|
| Leukemia caused by benzene                                       | 511             | 45.79          |
| Lung cancer caused by coke oven emission                         | 266             | 23.84          |
| Lung cancer and mesothelioma caused by asbestos                  | 226             | 20.25          |
| Lung cancer caused by hexavalent chromium compounds              | 42              | 3.76           |
| Bladder cancer caused by benzidine                               | 41              | 3.67           |
| Lung cancer and skin cancer caused by arsenic and its compounds  | 15              | 1.34           |
| Lung cancer caused by chloromethyl ether and dichloromethyl ether| 13              | 1.16           |
| Skin cancer caused by coal tar, coal tar pitch, petroleum pitch  | 1               | 0.09           |
| Bladder cancer caused by β-naphthylamine                         | 1               | 0.09           |
| Total                                                            | 1,116           | 100.00         |
As for the industrial distribution, the cases were mainly distributed in manufacturing (913, 81.18%), followed by mining (41, 3.67%), transportation, storage, and postal services (39, 3.49%) (Table 2). In manufacturing, leukemia caused by benzene topped the list of occupational cancers cases, while mining and transportation reported the most lung cancer and mesothelioma cases caused by asbestos. Among the total reported cases of occupational cancers, 870 (77.96%) were male and 246 (22.04%) were female cases. The average age at diagnosis of all reported cases was 51.91±15.85 years old, and the median exposure duration to occupational hazards was 12 (5.29–23.25) years. The distribution characteristics of the 3 major occupational cancers showed that for leukemia caused by benzene, 68.88% of the cases were male, the average age at diagnosis was (39.76±10.57) years, and the median exposure duration to occupational hazards was 6.17 years (Table 3). Compared with leukemia caused by benzene, the proportions of male cases of lung cancer caused by coke oven emissions and lung cancer and mesothelioma caused by asbestos were higher at 96.24% and 70.35%, respectively. The average age at diagnosis were higher than that of leukemia caused by benzene, which were (62.64±10.99) years and (63.52±11.19) years, respectively. The exposure duration to occupational hazards was longer than that of leukemia caused by benzene which were 24.25 years and 18.54 years, respectively.

**CONCLUSIONS**

Work-related carcinogens were responsible for a significant disease burden worldwide. According to Global Burden of Disease 2016 estimates (5), the burden of cancer due to exposure to 14 IARC Group 1 occupational carcinogens (asbestos, benzene, diesel engine exhaust, silica, etc.) was estimated at 349,000

| TABLE 2. Occupational cancer cases reported by industry, 2006–2020. |
|---------------------------------------------------------------|
| **Industrial classification** | **Number of cases** | **Proportion (%)** |
| Manufacturing | 913 | 81.81 |
| Mining | 41 | 3.67 |
| Transport, storage, and postal services | 39 | 3.49 |
| Production and supply of electricity, heat, gas, and water | 21 | 1.88 |
| Leasing and commercial services | 20 | 1.79 |
| Wholesale and retail trades | 18 | 1.61 |
| Construction | 16 | 1.43 |
| Public administration, social security, social organizations | 13 | 1.16 |
| Resident, repair and other services | 9 | 0.81 |
| Scientific research and technical services | 7 | 0.63 |
| Education | 7 | 0.63 |
| Health and social services | 5 | 0.45 |
| Agriculture, forestry, animal husbandry and fishery | 3 | 0.27 |
| Administration of water conservancy, environment, public facilities | 2 | 0.18 |
| Finance | 1 | 0.09 |
| Real estate | 1 | 0.09 |
| Total | 1,116 | 100.00 |

| TABLE 3. Demographic characteristics of 3 main occupational cancers, 2006–2020. |
|------------------------------------------------------------------|
| **Demographic characteristics** | **Leukemia caused by benzene (N=511)** | **Lung cancer caused by coke oven emission (N=266)** | **Lung cancer and mesothelioma caused by asbestos (N=226)** |
| Gender, n (%) | | | |
| Male | 352 (68.88) | 256 (96.24) | 159 (70.35) |
| Female | 159 (31.12) | 10 (3.76) | 67 (29.65) |
| Age (±s) | 39.76±10.57 | 62.64±10.99 | 63.52±11.19 |
| Exposure duration, Median (inter quartile range) | 6.17 (3.17–11.58) | 24.25 (14.33–31.33) | 18.54 (11.83–28.17) |
exposed to the same industrial disease hazards, the employed by several employers with similar jobs and high mobility of workers in China, who are usually and development of occupational cancers. As there is a workplace and the latency period for the occurrence cumulative occupational exposure to carcinogens in the cancers should meet the requirements of years of total exposure to carcinogens, and after a 9\(^{\text{th}}\) year makes it difficult to determine occupational awareness and that the long latency period of cancer workers probably lack relevant knowledge and diagnosed and reported. The problem is that most occupational cancers and the low number of cases discrepancy between the high morbidity of occupational mesothelioma, and there is a large reported to the cancer registry in 2016 was 583.

Asbestos is the most important contributor to occupational mesothelioma, and there is a large discrepancy between the high morbidity of occupational cancers and the low number of cases diagnosed and reported. The problem is that most workers probably lack relevant knowledge and awareness and that the long latency period of cancer onset makes it difficult to determine occupational carcinogen exposure history. According to the diagnostic criteria for an occupational cancer in China (9), there must be a clear history of long-term occupational exposure to carcinogens, and after a comprehensive analysis, the occurrence of primary cancers should meet the requirements of years of total cumulative occupational exposure to carcinogens in the workplace and the latency period for the occurrence and development of occupational cancers. As there is a high mobility of workers in China, who are usually employed by several employers with similar jobs and exposed to the same industrial disease hazards, the working year of some patients at the last employer may not meet the diagnostic criteria of exposure years (10), which makes the diagnosis of occupational cancers difficult.

In summary, occupational cancers may be underestimated in China. Diagnosis and surveillance of occupational cancers should be strengthened, and a comprehensive surveillance system including occupational health monitoring, carcinogens monitoring in workplaces, and occupational disease reporting should be established and improved to better evaluate the prevalence and disease burden of occupational cancers and protect workers' health.

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REFERENCES

1. Jin TY, Sun GF. Occupational health and occupational medicine. 6th ed. Beijing: People’s Medical Publishing House. 2008; p. 276. (In Chinese).

2. International Agency for Research on Cancer. Overall evaluations of carcinogenicity: an updating of IARC monographs. Lyon: IARC. 2004.

3. Purdue MP, Hutchings SJ, Rushlon L, Silverman DT. The proportion of cancer attributable to occupational exposures. Ann Epidemiol 2015;25(3):188 - 92. http://dx.doi.org/10.1016/j.annepidem.2014.11.009.

4. National Health and Family Planning Commission, Ministry of Human Resources and Social Security, General Administration of Safety Supervision, All-China Federation of Trade Unions. Classification and Catalogue of Occupational Diseases. http://www.mohrrs.gov.cn/SYLzrshzhbsh/shechuibaozhong/zcyw/gongsheng/ 201401r20140108_121649.html. [2013–12–25]. (In Chinese).

5. GBD 2016 Occupational Carcinogens Collaborators. Global and regional burden of cancer in 2016 arising from occupational exposure to selected carcinogens: a systematic analysis for the Global Burden of Disease Study 2016. Occup Environ Med 2020;77(3):151 – 9. http://dx.doi.org/10.1136/oemed-2019-106012.

6. World Health Organization, International Labour Organization. WHO/ILO joint estimates of the work-related burden of disease and injury, 2000–2016: global monitoring report. Geneva: World Health Organization; 2021.

7. Deutsche Gesetzliche Unfallversicherung. Recognized cases of OD. https://dguv.de/en/facts-figures/ods/recognized-od/index.jsp. [2021–07–05].

8. He J, Wei WQ. China cancer registry annual report 2019. Beijing: People’s Medical Publishing House. 2021; p. 216. (In Chinese).

9. National Health and Family Planning Commission of PRC. GBZ 94–2017 Diagnosis of occupational tumor. Beijing: Standards Press of China. 2017. (In Chinese).

10. Zheng QL, Xia LH, Hu SJ, Chen JB, Hua M, Liang WH, et al. Diagnosis of new occupational lung tumor in Guangdong province. China Occup Med 2019;46(6):678–83. https://d.wanfangdata.com.cn/periodical/zgzyyx201906006. (In Chinese).