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Preplanned Studies

Perspectives

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Cover Photo: The basidiomata of Inosperma muscarium (provided by Qin Liang, Hezhou CDC).

Preplanned Studies

Mushroom Poisoning Outbreaks — China, 2021

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Summary

What is already known about this topic?

Mushroom poisoning is one of the most serious food safety issues in China. Most poisoning incidents resulted from eating mushrooms causing gastroenteritis and psycho-neurological disorder from which patients usually could fully recover. Most deaths resulted from species causing acute liver failure and rhabdomyolysis, and the remaining deaths were attributed to acute renal failure and hemolysis.

What is added by this report?

In 2021, the total number of investigations was 327 from 25 provincial-level administrative divisions, involving 923 patients and 20 deaths, and the overall mortality was 2.17%. Overall, 74 poisonous mushrooms causing 6 different clinical syndromes were successfully identified, 15 of which were newly recorded in China as poisonous mushrooms.

What are the implications for public health practice?

Considering the potential huge risks for collecting and eating wild mushrooms, we strongly advise not collecting and eating unfamiliar wild mushrooms. Promoting knowledge about poisonous mushrooms is essential and urgent to reduce mushroom poisonings. Precise species identification timely after mushroom poisoning is important for appropriate diagnosis and treatment. Many deaths were ascribed to delayed hospitalization.

In recent years, an efficient mushroom poisoning control and prevention working system involving governments, clinical doctors, CDC experts, and mycologists has been established in China (*1–2*). Based on the technical support network, mushroom poisoning information was systematically collected by WeChat, telephone calls, and E-mails. Mushroom samples were collected by CDC staff or hospital professionals. Species identification depending on morphological observations and DNA data were carried out by mycologists from China CDC, universities, and research institutes nationwide. Related clinical symptoms data were summarized from the hospital records (*1–2*). In 2021, 327 independent mushroom poisoning incidents from 25 provincial-level administrative divisions (PLADs) involving 923 patients and 20 deaths were investigated. About 74 poisonous mushrooms resulting in 6 different clinical syndromes were successfully identified. Among the 74 species, 15 species were newly recorded in China. *Hygrocybe rimosa*, *Inosperma muscarium*, and *Pseudosperma arenarium* nom. prov. were three new species discovered in China. *Mallocybe fulvoumbonata*, *Psilocybe ovoideocystidiata*, and *P. papuana* were 3 records new to China, and the 9 remaining previously edibility unclear species were confirmed to be poisonous from poisoning incidents.

In 2021, a total of 327 mushroom poisoning incidents involving 923 patients and 20 deaths were investigated and the overall mortality was 2.17%. The number of cases ranged from 1 to 20, the average number of cases per incident was 2, and 6 incidents involved more than 10 patients. Of these cases, 68 patients from 14 incidents ate poisonous mushrooms purchased from a market or given by friends; 46 patients from 10 incidents were poisoned after eating dried mushrooms and 113 patients from 28 incidents ate mixed mushrooms.

Monthly distribution analysis showed that mushroom poisonings occurred every month, centered from May to November involving 294 incidents, 796 patients, and 18 deaths, and reached its peak in August (Figure 1). The first death appeared in early March from Guangdong. The top 3 months for deaths caused by poisonous mushrooms were September, July, and November with 7, 5, and 4 deaths, respectively.

In terms of geographical distribution, mushroom poisoning incidents were reported in 25 PLADs. Overall, 10 PLADs had over 10 incidents, and Hunan, Yunnan, Sichuan, Fujian, and Guizhou were the top 5 PLADs; 12 PLADs had over 20 patients and Yunnan, Hunan and Sichuan were the top 3 PLADs. Yunnan, Guizhou, and Guangdong had 4 deaths, Sichuan and

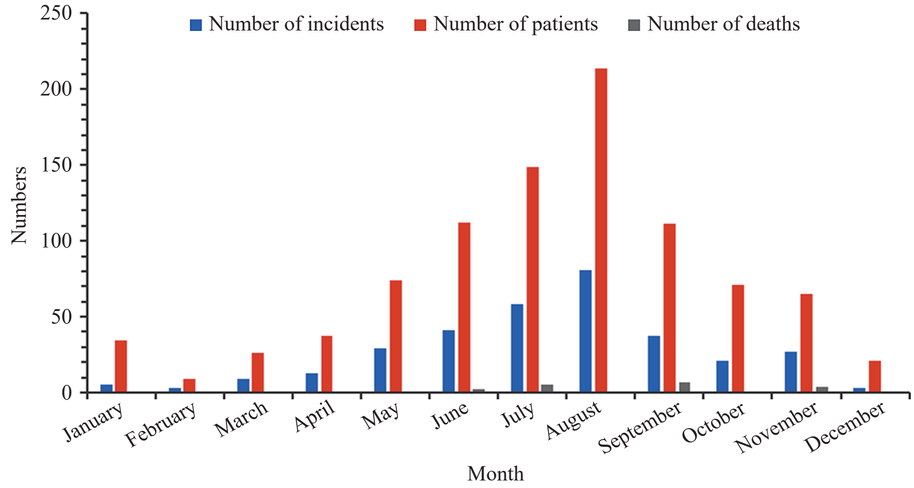

FIGURE 1. Monthly distribution of mushroom poisonings in China, 2021

Shanxi had 2 deaths, followed by Hunan, Guangxi, Beijing, and Xizang (Tibet) with 1 death each, and the remaining 16 PLADs had no deaths. Southwest China [Yunnan, Sichuan, Guizhou, Chongqing, and Xizang (Tibet)] was the most severely affected region with 138 incidents, 426 patients, and 11 deaths. Detailed information for each PLAD was shown in Table 1.

In 2021, 74 species of poisonous mushrooms caused 6 different clinical syndromes; acute liver failure, acute renal failure, rhabdomyolysis, hemolysis, gastroenteritis, and psycho-neurological disorder were successfully identified (Supplementary Table S1, available in http://weekly.chinacdc.cn/). A total of 15 species were newly recorded as poisonous mushrooms and were added to the Chinese poisonous mushroom list. *Hygrocybe rimosa*, which causes gastroenteritis, *Inosperma muscarium* and *Pseudosperma arenarium* nom. prov., which stimulated parasympathetic nervous system, were three new species discovered in China. *Mallocybe fulvoumbonata*, *Psilocybe ovoideocystidiata,* and *P. papuana* resulted in psycho-neurological disorders were three records new to China. *Agaricus atrodiscus*, *Boletellus indistinctus*, *Lactarius purpureus*, *L. rubrocorrugatus*, *Lactifluus pseudoluteopus*, *Melanoleuca humilis*, *Ramaria gracilis,* and *Scleroderma* aff. *albidum* cause gastroenteritis, and *Inocybe* aff. *glabrodisca* stimulates the parasympathetic nervous system; these species were confirmed to be poisonous from poisoning incidents.

The top three lethal mushroom species were *Russula subnigricans*, *Galerina sulciceps,* and *Lepiota brunneoincarnata*, which caused 6, 5, and 3 deaths, respectively. *Chlorophyllum molybdites*, the most widely distributed mushroom (discovered in 13 PLADs),

TABLE 1. Geographical distribution of mushroom poisoning incidents in China, 2021.

Location	Number of incidents	Number of patients	Deaths	Case fatality rate (%)
Hunan	64	159	1	0.63
Yunnan	59	200	4	2.00
Sichuan	34	98	2	2.04
Fujian	32	82	0	0
Guizhou	26	69	4	5.80
Zhejiang	21	50	0	0
Chongqing	17	53	0	0
Guangdong	16	33	4	12.12
Ningxia	13	26	0	0
Guangxi	12	42	1	2.38
Jiangsu	4	24	0	0
Hainan	4	11	0	0
Jiangxi	4	4	0	0
Shandong	3	20	0	0
Hubei	3	7	0	0
Beijing	2	14	1	7.14
Anhui	2	7	0	0
Shaanxi	2	4	0	0
Hebei	2	3	0	0
Xizang	2	2	1	50.00
Inner Mongolia	1	5	0	0
Xinjiang	1	4	0	0
Shanxi	1	3	2	66.67
Tianjin	1	2	0	0
Jilin	1	1	0	0
Total	327	923	20	2.17

caused the most poisonings incidents (appearing in 66 incidents affecting 123 patients) and had distinct long active period (from middle April to late December).

In 2021, 8 species (6 *Amanita* spp., 1 *Galerina* sp., and 1 *Lepiota* sp.) causing acute liver failure were identified in China (Supplementary Table S1, available in http://weekly.chinacdc.cn/). *Galerina sulciceps* killed 5 persons in 14 incidents involving 39 patients turned out to be the most dangerous species causing acute liver failure. *Lepiota brunneoincarnata* was responsible for 3 deaths in 15 incidents involving 45 patients, and this is the first report for its distribution in Yunnan Province (*1–3*). *Amanita fuligineoides* was originally described from Hunan and known from Yunnan as well (*4–5*). In late June, 2021, 5 people from Fujian were poisoned by this lethal species, which is indicative of a wider distribution of *A. fuligineoides*.

Three species causing acute renal failure were identified from mushroom poisoning incidents (Supplementary Table S1, available in http://weekly.chinacdc.cn/). *Amanita oberwinklerana* caused the most incidents. It grew in March in Guangdong, then appeared from July to August in Central and Southwest China. *Amanita kotohiraensis* was responsible for poisoning 2 patients on August 19.

Exposure to *Russula subnigricans* lead to rhabdomyolysis causing 6 deaths; this species was found in 9 PLADs and appeared from May 10 to September 9. A total of 2 incidents involving 2 patients and 1 death caused by *Paxillus involutus* resulting in hemolysis occurred in Lasa, Xizang (Tibet).

A total of 39 species causing gastroenteritis were identified from mushroom poisoning incidents in China in 2021 (Supplementary Table S1, available in http://weekly.chinacdc.cn/). Among them, *Agaricus atrodiscus*, *Boletellus indistinctus*, *Hygrocybe rimosa*, *Lactarius purpureus*, *L. rubrocorrugatus*, *Lactifluus pseudoluteopus*, *Melanoleuca humilis*, *Ramaria gracilis*, and *Scleroderma* aff. *albidum* were species newly discovered as poisonous mushrooms and subsequently added to the Chinese poisonous mushroom list (*1–3*). *Hygrocybe rimosa* was a new species discovered in 2021 (*6*). Notably, *A. atrodiscus* poisoning was reported for the first time from Yunnan since it was originally described from Thailand in 2015 (*7*) and discovered in Hainan Province, China, in 2020 (*8*). The top three species in this category were *C. molybdites*, *R. japonica* and *Entoloma omiense*.

About 22 species causing psycho-neurological disorders were identified from mushroom poisoning incidents in China in 2021 (Supplementary Table S1, available in http://weekly.chinacdc.cn/). Among them, 6 species (*Inocybe* aff. *glabrodisca*, *Inosperma muscarium*, *Pseudosperma arenarium* nom. prov., *Mallocybe fulvoumbonata*, *Psilocybe ovoideocystidiata,* and *P. papuana*) were newly discovered as poisonous mushrooms (*1–3*). *Inosperma muscarium* and *Pseudosperma arenarium* were two new species. The former species was described in 2021 (*9*) and the latter was identified as *P.* cf. *bulbosissimum* in 2020 (*2*). Further study showed that *P.* cf. *bulbosissimum* was a new species. *Mallocybe fulvoumbonata*, *P. ovoideocystidiata,* and *P. papuana* were Chinese new records. The top five species were *Amanita subglobosa*, *Gymnopilus dilepis*, *A. pseudosychnopyramis*, *Inosperma muscarium*, and *Pseudosperma arenarium*.

Nine boletes (*Baorangia major*, *B. pseudocalopus*, *Boletellus indistinctus*, *Heimioporus gaojiaocong*, *H. japonicus*, *Neoboletus venenatus*, *Rubroboletus sinicus*, *Suillus pinetorum*, and *Tylopilus neofelleus*) causing gastroenteritis and one (*Lanmaoa asiatica*) causing psycho-neurological disorder were identified from poisoning incidents.

Interestingly, 2 incidents caused by polypores occurred in 2021. On February 28, 2021, one person from Guangxi had slight gastrointestinal symptoms after consumption of *Cryptoporus volvatus*, a recorded medicinal polypore (*3*). On the same date, one person from Guangdong also suffered gastroenteritis after drinking boiled water using dried "medicinal mushrooms." This mixture was confirmed as medicinal or edible mushrooms, *Trametes hirsuta*, *Irpex lacteus*, and *Schizophyllum commune* (*3*). Their toxicity and safe usage need to be further studied.

About 6 edible mushrooms were also identified from mushroom poisoning incidents in 2021, which could be attributed to the consumption of mixed mushrooms with poisonous mushrooms, contaminated mushrooms, or some species potentially poisonous to certain people.

DISCUSSION

In 2021, mushroom poisoning incidents and patients were more than 2019 but less than 2020 as deaths slightly decreased (20 *vs*. 22 and 25) (*1–2*). Shaanxi, Xinjiang, Tianjin, and Jilin were four PLADs with newly recorded incidents (*1–2*). Approximately 74 poisonous mushrooms were successfully identified, among which 46 species were already recorded in 2019 and 2020 (*1–2*), raising the total species number from incidents reached over 150 in China by the end of

2021. The most dangerous mushroom was *Russula subnigricans*, killing 6 people in 2021, differing from *Amanita exitialis* that killed 13 people in 2019 and *Lepiota brunneoincarnata* that killed 5 people in 2020 (*1*–*2*).

Monthly distribution analysis showed that mushroom poisonings in 2021 centered from May to November, longer than 2019 and 2020, peaking in August, which was later than the July peak in 2019, and different from 2020 that had 2 peaks in June and September (*1*–*2*).

The top two PLADs with the most incidents were Hunan and Yunnan in 2021, identical to 2019 and 2020, and Southwest China remained the most severely affected area (*1*–*2*). Yunnan had the most deaths in the last three years, but declined markedly (*1*–*2*). Mushroom poisoning incidents decreased sharply in Zhejiang from 50 in 2019 to 43 in 2020 and to 21 in 2021 (*1*–*2*).

Mushroom poisoning resulting acute liver failure caused by *Amanita* spp. dropped sharply from 32 incidents, 80 patients, and 19 deaths in 2019 (*1*), to 53 incidents, 153 patients and 10 deaths in 2020 (*2*), and to 17 incidents, 52 patients and 5 deaths in 2021. This great progress mainly contributed to the continuous science popularization and health education on *Amanita* spp. *Galerina sulciceps* poisoning increased from 4 incidents, 9 patients, and 1 death in 2019 (*1*), to 6 incidents, 12 patients, and 2 deaths in 2020 (*2*), and to 14 incidents, 39 patients, and 5 deaths in 2021. Except appearing in autumn and winter, *G. sulciceps* also resulted 1 death in April in Hunan. Attention must also be paid to *Lepiota brunneoincarnata* that caused 3 incidents in 2019 and 15 incidents in 2020 and 2021. Continuous and extensive science popularization about these lethal species were necessary and urgent in future.

Similar to 2019 and 2020, *Amanita oberwinklerana* caused the most incidents, but resulted in relatively less incidents and patients than the last two years (*1*–*2*). *Amanita kotohiraensis* was discovered from one mushroom poisoning incident and expanded its distribution to Fujian (*5*).

Compared to 2019 and 2020, *Russula subnigricans* leading to rhabdomyolysis caused more deaths (6 *vs.* 1 and 4), was discovered in more PLADs (9 *vs.* 5 and 4), and appeared earlier (*1*–*2*). *Paxillus involutus* resulting in hemolysis appeared earlier in Xizang (Tibet) than in Inner Mongolia, 2020 (*2*). On account of the huge risk of eating this mushroom, we strongly advise not collecting and eating this species although it was previously accepted as edible and medicinal fungus in China and seems safe to many people (*2*).

Overall, 39 species causing gastroenteritis were successfully identified in 2021, which was more than 2019 (30 species) and less than 2020 (56 species), and the top three species were *Chlorophyllum molybdites*, *Russula japonica*, and *Entoloma omiense*, the same as 2019 and 2020 (*1*–*2*).

Lactifluus pseudoluteopus was a species originally described from tropical Yunnan and was considered as edible (*10*). In 2020, 5 people experienced gastroenteritis after eating *Lf. pseudoluteopus*, and we suspected the species might be poisonous (*2*). Subsequently, on June 4, 2021, another person also developed gastroenteritis after eating *Lf. pseudoluteopus* and we now could confirm that this species is toxic (*10*).

Many species from *Agaricus* section *Xanthodermatei* were considered poisonous as they resulted in gastroenteritis, and 7 species were discovered in China by 2019 (*3*). In 2021, *Agaricus atrodiscus* and *A. xanthodermus* were identified from mushroom poisoning incidents. This was the first poisoning incident report caused by *A. atrodiscus* worldwide and supplemented poisoning information of *A. xanthodermus* (*3*,*7*).

Omphalotus guepiniformis caused poisoning incidents in East, Central, South, and Southwest China in the recent years, whereas *O. olearius* poisoning only occurred in Yunnan Province (*1*–*2*). On July 11 and October 3, 2021, 22 persons were poisoned by a white, wood-rotting fungus which was similar to *Pleurotus* spp. Further studies showed that it might be an undescribed species of *Omphalotus* species, and we temporarily recorded it as *Omphalotus* sp. in the present investigation.

Coprinellus micaceus, *Coprinopsis atramentaria*, and *Coprinus comatus* were three common and widely distributed mushrooms resulted several poisoning incidents in 2021. They could produce coprine, especially when mature, and thus resulted in disulfiram-like mushroom poisoning when consumed with alcohol (*11*). In China, *Cp. atramentaria* and *C. comatus* were also considered edible, and *C. comatus* has been widely cultured commercially. *Coprinellus micaceus* was also considered as medicinal fungus (*3*). For the sake of safety, we strongly advise not eating these three species collected from the field and drinking alcohol when consuming cultured *C. comatus*.

Baorangia major was firstly discovered in Fujian and Yunnan and resulted in 2 poisoning incidents either individually or in conjunction with *B. pseudocalopus* consumption in 2020 (*2*), and caused another incident in Fujian, 2021. Previously, *Neoboletus venenatus* was often discovered from incidents who consumed dried boletes (*1–2*). On September 19, 2021, 7 people from Yunnan were poisoned after eating fresh basidiomata. On August 19, 2021, 1 person from Fujian suffered gastroenteritis after eating a red bolete. Our study indicated that it might be a new species and temporarily recorded as *Rubroboletus* sp.

About 22 species causing psycho-neurological disorders were identified in 2021, which was more than 2019 (18 species) but less than 2020 (28 species), and *Amanita subglobosa* occupied the first for the last three years (*1–2*). Except the 6 newly added poisonous species, the previously convincible poisonous species *A. ibotengutake*, *A. melleialba*, *A. pseudopantherina*, *A. pseudosychnopyramis*, and *Panaeolus bisporus* appeared in poisoning incidents in 2021 (*1–5*).

Amanita is the most famous genus worldwide since it includes many notorious poisonous mushrooms which could cause acute liver failure, acute renal failure, and psycho-neurological disorder (*1–3*, *5*, *11*). In China, many species are China-specific, 9 lethal species leading to acute liver failure and 10 species leading to psycho-neurological disorder were originally described from China (*4–5*), and their toxicity of many species had been confirmed from poisoning incidents (*1–2*). Although dozens of species of this genus are edible, on account of the high phenotypic similarity between edible and lethal species, we strongly advise not eating *Amanita* spp. unless the identity is fully determined.

Lanmaoa asiatica, commonly known as “red bolete with onion smell,” is a delicious bolete that needs properly cooking, which was originally described from China (*12*). When causing poisoning, this species could cause hallucinations. Different from species containing psilocybin, its toxicity is still unclear and needs further studies.

The incidents reported in this study only represent a portion of actual mushroom poisonings. In some poisoning incidents, some specimens cannot be given a satisfactory species name. More taxonomic work is needed and more new species will be hopefully discovered (*1–3*, *5–10*, *12*). The low level of awareness of mushroom poisoning, in contrast to the high species diversity in China is a huge challenge for mushroom poisoning control and prevention. The practice demonstrates that more efforts and closer cooperation are still urgently needed from governments, CDC staff, doctors, and mycologists to properly control mushroom poisoning events in the future.

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SUPPLEMENTARY TABLE S1. Mushroom species involved in poisoning incidents and their spatial and temporal distribution in China, 2021.

Clinical syndromes or mushroom species	Number of incidents	Number of patients	Deaths	Case fatality (%)	Spatial and temporal distribution
Acute liver failure					
Amanita exitialis	3	8	1	12.50	March 3, Guangdong; June 24 to 26, Yunnan
Amanita exitialis and *A. fuligineoides*	1	4	0	0	July 2, Yunnan
Amanita fuliginea and *A. oberwinklerana* [ARF]	1	5	0	0	July 5, Hunan
Amanita fuligineoides	2	9	1	11.11	June 25 and July 2, Fujian, and Yunnan
Amanita pallidorosea	1	2	0	0	June 19, Hunan
Amanita rimosa	1	3	0	0	June 2, Hunan
Amanita subjunquillea	1	2	0	0	September 17, Sichuan
Amanita spp.	7	19	3	15.79	June 22 to July 26, Yunnan, Hunan, Chongqing, and Zhejiang
Galerina sulciceps	14	39	5	12.82	April 16, Hunan; November 3 to 30, Sichuan, Chongqing, Hubei, Guizhou, and Hunan
Galerina sp.	1	18	0	0	December 28, Sichuan
Lepiota brunneoincarnata	15	45	3	6.67	July 4 to September 28, Yunnan, Hebei, Shanxi, Xinjiang, Shandong, Inner Mongolia, Ningxia, Shaanxi, Jilin, Beijing, and Tianjin
Rhabdomyolysis					
Russula subnigricans	16	50	6	12.00	May 10 to September 9, Yunnan, Zhejiang, Hunan, Jiangsu, Fujian, Jiangxi, Guizhou, Guangdong, and Guangxi
Acute renal failure					
Amanita kotohiraensis	1	2	0	0	August 19, Fujian
Amanita oberwinklerana	6	9	0	0	mid-March, Guangdong; July 20 to August 29, Hubei, Sichuan, and Guizhou
Amanita aff. *pseudoporphyria*	2	2	0	0	August 22 and 23, Hunan
Hemolysis					
Paxillus involutus	2	2	1	50.00	July 31 and August 7, Xizang
Gastroenteritis					
Agaricus atrodiscus	1	6	0	0	July 28, Yunnan
Agaricus xanthodermus	1	1	0	0	April 29, Hunan
Agaricus sp.	1	2	0	0	August 20, Hunan
Baorangia major	1	5	0	0	May 28, Fujian
Baorangia pseudocalopus	2	8	0	0	June 23, Yunnan; September 17, Hunan
Boletellus indistinctus	1	6	0	0	August 3, Yunnan
Chlorophyllum aff. *globosum*	2	8	0	0	August 30 and September 5, Sichuan
Chlorophyllum hortense	2	3	0	0	August 12 to September 29, Hunan, and Guangxi
Chlorophyllum molybdites	65	120	0	0	April 15 to December 27, Zhejiang, Guizhou, Hunan, Hainan, Fujian, Guangdong, Guangxi, Yunnan, Sichuan, Chongqing, Jiangsu, Hubei and Jiangxi
Chlorophyllum molybdites and *Cordyceps gunnii* [M]	1	3	0	0	August 21, Guizhou
Coprinellus micaceus	1	1	0	0	September 29, Beijing
Coprinellus micaceus and *Panaeolus bisporus* [P]	1	3	0	0	September 20, Ningxia
Coprinopsis atramentaria	1	1	0	0	April 19, Shandong
Coprinus comatus	1	1	0	0	October 19, Sichuan

Continued

Clinical syndromes or mushroom species	Number of incidents	Number of patients	Deaths	Case fatality (%)	Spatial and temporal distribution
Cryptoporus volvatus [M]	1	1	0	0	February 28, Guangxi
Entoloma caespitosum	1	4	0	0	May 24, Fujian
Entoloma omiense	7	22	0	0	June 6 to August 30, Fujian, Guangdong, Yunnan, Zhejiang, and Guizhou
Entoloma aff. *strictius*	1	3	0	0	April 12, Hunan
Entoloma aff. *sinuatum*	1	9	0	0	August 8, Yunnan
Gymnopus densilamellatus, *G. dryophilus* [G] and *Ripartites tricholoma* [U]	1	2	0	0	August 6, Hebei
Gymnopus indoctus [U], *Leucoagaricus sinicus* [U], *Panaeolus papilionaceus* [P], *Ileodictyon gracile*[U] and *Agaricus* sp. [U]	1	4	0	0	October 14, Guangdong
Heimioporus gaojiaocong	3	5	0	0	January 12, Yunnan (dried boletes bought from market); June 3 to July 20, Yunnan
Heimioporus japonicus	2	9	0	0	August 26 and September 7, Fujian
Hygrocybe rimosa	1	2	0	0	July 1, Guizhou
Lactarius purpureus	1	1	0	0	August 29, Hunan
Lactarius rubrocorrugatus	2	7	0	0	July 11 and 27, Sichuan
Lactifluus pseudoluteopus	1	1	0	0	June 4, Yunnan
Melanoleuca humilis	1	2	0	0	September 15, Ningxia
Neoboletus brunneissimus [E,M], *Butyriboletus yicibus* [E], *Catathelasma subalpinum* [E] and *Cortinarius similis* [U]	1	3	0	0	August 16, Sichuan (dried boletes from Yunnan)
Neoboletus venenatus	3	12	0	0	March 10 and July 2, Hunan and Sichuan (dried boletes, bought from market); September 19, Yunnan
Omphalotus guepiniformis	1	3	0	0	May 1, Guizhou
Omphalotus olearius	2	4	0	0	July 28 and October 18, Yunnan
Omphalotus sp.	4	44	0	0	July 11 and October 18, Yunnan
Pholiota multicingulata	1	4	0	0	September 13, Chongqing
Ramaria gracilis	1	1	0	0	August 28, Yunnan
Rubroboletus sinicus and *Retiboletus fuscus* [E]	1	20	0	0	January 11, Jiangsu (dried boletes bought from market)
Rubroboletus sp.	1	1	0	0	August 19, Fujian
Russula foetens	1	1	0	0	August 26, Fujian
Russula japonica	24	70	0	0	May 25 to August 26, Guangxi, Hunan, Sichuan, Guizhou, Yunnan, Chongqing, Fujian, and Zhejiang
Russula japonica and *R. punctipes* [G]	1	2	0	0	May 31, Hunan
Russula leucocarpa [U] and *Russula* sp.	1	4	0	0	September 4, Fujian
Russula punctipes	1	6	0	0	August 23, Hunan
Scleroderma* aff. *albidum	2	9	0	0	March 7 and July 9, Guangxi and Sichuan
Scleroderma cepa	4	7	0	0	July 5 to August 25, Yunnan; October 27 to November 15, Hunan
Suillus pinetorum, *Amanita javanica* [E], *Boletus bainiugan* [E] and *Phlebopus portentosus* [E]	1	8	0	0	April 15, Yunnan
Thicholoma highlandense	1	1	0	0	November 20, Guizhou
Trametes hirsuta [M], *Irpex lacteus* [M] and *Schizophyllum commune* [E,M]	1	1	0	0	February 28, Guangdong (dried mushrooms from Sichuan)
Tricholoma stans	1	2	0	0	November 3, Yunnan
Tricholoma aff. *stans*	2	5	0	0	November 2 and December 1, Guizhou and Yunnan

Continued

Clinical syndromes or mushroom species	Number of incidents	Number of patients	Deaths	Case fatality (%)	Spatial and temporal distribution
Psycho-neurological disorder					
Amanita ibotengutake	1	17	0	0	September 5, Shandong
Amanita melleialba	1	1	0	0	August 10, Yunnan
Amanita orientigemmata	1	2	0	0	August 10, Yunnan
Amanita pseudopantherina	1	1	0	0	August 9, Yunnan
Amanita pseudosychnopyramis	2	11	0	0	April 6 and 15, Fujian and Zhejiang
Amanita orsonii and *Amanita* sp. U	1	3	0	0	June 29, Chongqing
Amanita rufoferruginea	1	6	0	0	July 6, Sichuan
Amanita subglobosa	4	13	0	0	June 29 to August 19, Sichuan and Hunan
Amanita sychnopyramis f. *subannulata*	1	5	0	0	May 28, Guangxi
Clitocybe subditopoda	1	3	0	0	October 26, Guizhou
Clitocybe sp.	1	2	0	0	October 18, Hainan
Gymnopilus dilepis	3	5	0	0	May 1 to July 2, Sichuan and Guizhou
Inocybe* aff. *glabrodisca	1	4	0	0	November 26, Guizhou
Inosperma muscarium	2	7	0	0	May 30 and June 5, Guangxi and Fujian
Lanmaoa asiatica	1	1	0	0	July 2, Yunnan
Lanmaoa asiatica, *Heimioporus japonicus* G and *Tylopilus neofelleus* G	1	4	0	0	January 27, Chongqing (dried boletes bought from market)
Panaeolus bisporus	1	2	0	0	August 14, Guizhou
***Pseudosperma arenarium* nom. prov.**	2	3	0	0	September 22 and 30, Ningxia and Shaanxi
Pseudosperma umbrinellum and ***Mallocybe fulvoumbonata*** P	1	2	0	0	September 21, Ningxia
Psilocybe ovoideocystidiata	1	2	0	0	March 26, Guizhou
Psilocybe papuana	1	2	0	0	April 30, Hunan
Unclassified					
Cortinarius cupreorufus U	1	3	0	0	September 3, Ningxia
Laccaria vinaceoavellanea E	1	2	0	0	August 1, Yunnan
Leucoagaricus barssii E	1	2	0	0	September 6, Ningxia
Porphyrellus nigropurpureus U	1	4	0	0	August 1, Fujian
Russula densifolia E	1	2	0	0	August 13, Yunnan
Scleroderma yunnanense E	1	4	0	0	July 2, Yunnan
Stropharia rugosoannulata E	2	2	0	0	April 29 and May 16, Hunan and Chongqing
Tricholoma myomyces E	1	2	0	0	March 16, Hunan

Note: Species newly recorded as poisonous mushrooms in China are in italic bold.
Abbreviations used for mushroom poisoning incidents with more than two species: ARF=Acute renal failure, G=Gastroenteritis, P=Psycho to neurological disorder, M=Medicinal, U=Unclassified, E=Edible.

Preplanned Studies

Prevalence, Incidence, and Characteristics of Tuberculosis Among Known Diabetes Patients — A Prospective Cohort Study in 10 Sites, 2013–2015

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Summary

What is already known about this topic?

The association of diabetes mellitus (DM) with both increased risk of tuberculosis (TB) and unfavorable treatment outcomes has been identified by many studies (*1*). However, epidemic data for TB cases in DM patients is absent in China.

What is added by this report?

This current population-based prospective cohort study, conducted in ten counties located in eastern, central, and western China during 2013–2015, revealed a high prevalence and incidence of TB in known DM patients. Most TB cases were captured by active case-finding and a much higher presence of being asymptomatic among TB/DM patients was obtained.

What are the implications for public health practice?

Active case-finding should be carried out in DM patients and populations at high risk for developing TB. A TB symptom screening-based case-finding strategy is not enough; chest radiography check should be done once a year for these patients.

The evidence for positive association of diabetes mellitus (DM) and tuberculosis (TB) has been found by many studies regardless of study design and population (*1*), and the risk for developing TB increased among DM patients. China has a heavy burden for both DM and TB. During 2013–2015, there was an estimated number of TB cases between 0.918 million and 0.980 million, and meanwhile, China witnessed a high prevalence of DM in the past decade (*2*). And, there will also be an explosion in DM cases in China, with an estimated DM population of 20.8 million in 2000 and a projected number of 42.3 million by 2030 (*3*). Passive case finding was applied in DM patients in National Tuberculosis Control Program in China (China NTP), which likely resulted in underdiagnosed TB cases in DM patients, and the strong association between DM and TB and the high burden for these two diseases make a voice for more effective TB case finding in China. A population-based multicenter prospective cohort study for TB incidence in 10 study sites from 10 provincial-level administrative divisions in China was conducted during 2013–2015. This article used existing data to describe TB prevalence rate and incidence rate among patients with DM. The prevalence rates of bacteriologically-confirmed TB and active TB were 291.3/100,000 and 543.7/100,000, respectively; the incidence rates were 47.0/100,000 and 250.6/10,000, respectively. There was significant difference for both TB prevalence and TB incidence between genders, with or without previously treated TB and body mass index (BMI) level differentiation. About 81.8% of active TB was found by active screening. For TB patients identified by active screening, they had few TB symptoms present (less than 15%) and more mild illness than those identified by passive case finding, signifying the necessity of active case-finding for high-risk populations.

The detailed information on site selection, the procedure and measurements used in the prevalence survey, and follow-up in the elderly have been described fully in other papers (*4*–*5*). And this study utilized data on DM patients obtained from the same study and aimed to understand the TB epidemic in DM patients.

Eligible DM patients were identified by using a two-stage procedure. First, information was collected for all DM patients registered and managed in local National Project of Basic Public Health Service Project (NPHSP), which was launched by the Chinese Ministry of Health in 2011. Second, we made a door-to-door investigation to identify DM patients missed by the NPHSP.

All DM patients went through two phases: baseline and follow-up. In the baseline phase, each patient participated in a TB prevalence survey, which consisted of a questionnaire interview, chest X-ray examination (CXR); afterwards, a TB check was conducted for those with TB symptoms or abnormal CXR. In the follow-up phase, each DM patient without TB was followed up for two years to track TB incident cases by using both passive case-finding and yearly CXR.

A total of 6,025 DM patients were recruited for the study, with 5,180 managed and 845 missed by the local NPHSP project. Among all DM patients, 875 (11.8%) refused to receive screening and 5,150 finished all required diagnostic procedure. Overall, 28 TB cases were identified in the prevalence survey, leaving 5,122 DM patients in the incidence cohort. At the end of two-year follow-up period, 3,033 DM patients remained in the cohort for data analysis.

Of the 5,150 DM patients, 28 active pulmonary TB patients were found, 4 of them were previously known patients with TB and 24 were newly diagnosed with TB. The overall prevalence rates of bacteriologically-confirmed TB and clinically-diagnosed TB were 291.3/100,000 and 543.7/100,000, respectively. Table 1 shows TB prevalence for each group with different characteristics.

Of the 5,122 DM patients without TB, 6,383.6 person-years and 16 incident active pulmonary TB patients were obtained. The overall incidence rates of bacteriologically-confirmed TB and clinically-diagnosed TB in these person-years were 47.0/100,000 person-year and 250.6/100,000 person-year, respectively. Table 2 shows TB incidence for each group with different characteristics.

For 44 active TB patients with DM, including 28 found in baseline survey and 14 identified during the follow-up period, 8 cases (18.2%) were found by passive case-finding, and 36 cases (81.8%) were captured by active screening. The prevalences of TB symptoms were 50.0% and 70.4% in all bacteriologically-confirmed and clinically-diagnosed TB, respectively, and decreased to 18.2% and 13.9%, respectively, among TB cases identified by active screening. Significant differences of TB symptom prevalence existed between TB patients found by the two methods. In addition, most active TB patients had 1–2 lung fields lesion, and about 38% involved lower lung fields and both left and right lungs. Overall, 18% of TB patients presented cavitation in their chest imaging. These percentages increased in bacteriologically-confirmed TB patients (Table 3).

DISCUSSION

Our study is the first population-based and prospective cohort study in known DM patients, obtaining both prevalence and incidence rates of TB and describing TB symptom presence and characteristics of chest imaging change for DM/TB patients. The study also observed a higher prevalence of bacteriologically-confirmed TB in known DM patients than that for the general population based on data obtained from the Fifth National Tuberculosis Prevalence Survey. Compared with a retrospective cohort study conducted in Shanghai (*6*), our study obtained a much higher TB incidence rate in larger areas. Our active TB incidence was also higher than that obtained in a cohort study conducted in The Republic of Korea (*7*) and lower than that obtained in Indonesia (*8*). The reason underlying the difference is because there is a huge difference in TB epidemic in these regions/countries.

The analyses for both TB prevalence and TB incidence in several subgroups showed significant differences. Male DM patients with lower BMI had higher TB prevalence and incidence rates; these findings were like those identified in the general population and could be found in retrospective cohort study conducted in Shanghai (*6*). A history of previous TB was identified as a high-risk factor for developing TB by many studies (*9*). For persons with multiple risk factors, their risk for developing TB was much higher. Our analysis also indicated high TB prevalence and TB incidence for DM patients with previously treated TB.

Some pilot projects for TB screening among DM patients have been carried out in DM clinics and community health settings in the past few years (*10*). These pilots were based on TB symptoms, and five symptoms, including cough for longer than 2 weeks; night sweats for 4 weeks or longer, fever for 4 weeks or longer, weight loss over the previous 4 weeks, and any suspicion of active TB to account for extrapulmonary TB, were used. All these pilots reported that it is feasible to carry out TB screening on DM patients, and a high detection rate for TB was obtained in clinic. The high yield obtained in our study also identified the feasibility of conducting active case-finding in community settings.

Passive case-finding is still the main strategy for TB case-finding in the China NTP, covering DM patients. TB could be diagnosed for DM patients visiting hospital actively due to the presence of TB symptoms.

TABLE 1. Prevalence of tuberculosis for diabetes mellitus patients in 10 study sites in 2013.

Variables	No.	Bacteriologically confirmed TB			Active TB		
		No. of TB cases	Prevalence (1/100,000)(95%CI)	*P*	No. of TB cases	Prevalence (1/100,000)(95%CI)	*P*
Total	5,150	15	291.3(143.9−438.7)		28	543.7(342.3−745.1)	
Gender				0.281			0.002
Female	2,927	3	102.5(21.1−299.6)		8	273.3(117.9−538.4)	
Male	2,223	12	539.8(234.4−845.2)		20	899.7(505.4−1294)	
Age group, years				0.547			0.060
<55	1,037	2	192.9(23.3−696.2)		2	192.9(23.3−696.2)	
55–	1,707	5	292.9(94.9−683.7)		10	585.8(222.7−948.9)	
65–	1,585	3	189.3(39.1−553.3)		7	441.6(177.3−909.8)	
≥75	817	5	612.0(198.3−1,428.4)		9	1,101.6(504.3−2,090.6)	
Nationality				0.916			0.814
Han	4,834	14	289.6(137.9−441.3)		26	537.9(331.1−744.6)	
Others	313	1	319.5(8.1−1,779.6)		2	639(77.3−2,306.7)	
Education				0.798			0.656
Senior middle school and above	1,147	3	261.6(54.0−764.6)		5	435.9(141.2−1,017.4)	
Junior middle school and less	2,969	9	303.1(138.8−575.3)		16	538.9(274.8−803.0)	
Illiteracy	959	3	312.8(64.5−914.5)		7	729.9(293.0−1,503.6)	
With or without spouse				0.512			0.166
Yes	4,350	12	275.9(119.8−431.9)		21	482.8(276.3−689.2)	
No	800	3	375.0(77.4−1,096.3)		7	875.0(351.3−1,802.5)	
Residence							0.044
Locally	4,502	15	333.2(164.6−501.8)		25	555.3(337.6−773.0)	
Others	648	0	0.0(0.0−569.4)		0	0.0(0.0−569.4)	
Yearly income per person (CNY)				0.882			0.001
10,000 and above	3,173	4	126.1(34.4−322.7)		8	252.1(108.7−496.7)	
2,300–	1,508	9	596.8(273.2−1,132.6)		17	1,127.3(591.4−1,663.2)	
<2,300	352	2	568.2(68.8−2,051.1)		3	852.3(175.9−2,491.5)	
Years for diabetes				0.201			0.751
<10	2,368	8	337.8(145.7−665.5)		15	633.4(312.9−954.0)	
≥10	813	5	615.0(199.3−1,435.4)		6	738.0(270.6−1,606.4)	
Previously treated TB				0.885			<0.001
No	5,019	10	199.2(75.8−322.7)		19	378.6(208.3−548.8)	
Yes	131	5	3,816.8(1,236.6−8,908.4)		9	6,870.2(3,145−13,038.2)	
Chronic bronchitis				0.274			0.838
No	4,913	15	305.3(150.8−459.8)		27	549.6(342.3−756.9)	
Yes	224	0	0.0(0.0−1,647.3)		1	446.4(11.3−2,486.6)	
Pneumoconiosis				–*			0.824
No	5,136	15	292.1(144.3−439.9)		28	545.2(343.2−747.1)	
Yes	9	0	0.0(0.0−41,000.0)		0	0.0(0.0−41,000.0)	
Self-reported cigarette smoking				0.353			0.444
Never smoking	4,114	12	291.7(126.6−456.7)		24	583.4(350−816.8)	
Ever or current smoking	1,033	3	290.4(59.9−849.0)		4	387.2(105.5−991.3)	
Self-reported drinking				0.022			0.947
Never drinking	4,240	10	235.8(89.7−382.0)		23	542.5(320.8−764.1)	
Ever or current drinking	892	5	560.5(181.6−1,308.3)		5	560.5(181.6−1,308.3)	
BMI level				0.275			<0.001
<18.5	244	2	819.7(99.2−2,959.0)		6	2,459(901.6−5,352.5)	
18.5−	2,568	12	467.3(202.9−731.7)		18	700.9(377.1−1,024.7)	
24–	1,785	1	56.0(1.4−312.0)		3	168.1(34.7−491.3)	
28–	550	0	0.0(0.0−670.9)		1	181.8(4.6−1,012.7)	

Note: 10 study sites: located in Zhejiang, Jiangsu, Guangdong, Shanghai, Heilongjiang, Henan, Hubei, Sichuan, Guangxi, and Yunnan. Not all total numbers for subgroups were 5,150 because of missing data.
Abbreviations: DM=diabetes mellitus; TB=tuberculosis; BMI=body mass index.
* Unavailable result because of no enough TB cases in this subgroup.

TABLE 2. Incidence rates of tuberculosis in diabetes mellitus patient cohort in 10 study sites, 2013–2015.

Variables	Person-year	Bacteriologically confirmed TB			Active TB		
		No. of incident TB cases	Incidence (1/100,000 person-year) (95%CI)	*P*	No. of incident TB cases	Incidence (1/100,000 person-year) (95%CI)	*P*
Total	6,383.6	3	47.0(9.7−137.4)		16	250.6(127.8−373.5)	
Gender				0.340			0.006
Female	3,800.8	0	0.0(0.0−97.1)		4	105.2(28.7−269.4)	
Male	2,582.8	3	116.2(24.0−339.6)		12	464.6(201.7−727.5)	
Age group, years				0.103			0.408
<55	1,283.1	2	155.9(18.9−562.7)		3	233.8(48.2−683.5)	
55−	2,129.5	1	47.0(1.2−261.6)		4	187.8(51.2−480.9)	
65−	2,008.7	0	0.0(0.0−183.7)		5	248.9(80.7−581.0)	
≥75	960.3	0	0.0(0.0−384.3)		4	416.6(113.5−1,066.4)	
Nationality				0.800			<0.001
Han	5994.6	3	50.0(10.3−146.3)		12	200.2(86.9−313.4)	
Others	387.5	0	0.0(0.0−952.3)		4	1,032.3(281.3−2,642.8)	
Education				0.064			0.340
High school and above	1,154.8	2	173.2(21.0−625.2)		2	173.2(21.0−625.2)	
Secondary school and less	3,811.0	1	26.2(0.7−146.2)		13	341.1(155.7−526.6)	
Illiteracy	1,336.5	0	0.0(0.0−276.1)		1	74.8(1.9−416.8)	
With or without spouse				0.638			0.272
Yes	5,380.2	3	55.8(11.5−163.0)		16	297.4(151.7−443.1)	
No	1,003.4	0	0.0(0.0−367.8)		0	0.0(0.0−367.8)	
Residence				0.828			0.615
Locally	5,925.2	3	50.6(10.4−148.0)		16	270.0(137.7−402.4)	
Others	458.4	0	0.0(0.0−805.0)		0	0.0(0.0−805.0)	
Yearly income per person (CNY)				0.382			0.198
10,000 and above	3,586.5	3	83.6(17.3−244.5)		6	167.3(61.3−364.1)	
2,300–	2,139.1	0	0.0(0.0−172.5)		8	374.0(161.3−736.8)	
<2,300	502.1	0	0.0(0.0−734.9)		2	398.3(48.2−1,438.0)	
Years for diabetes				0.788			0.329
<10	3,433.2	2	58.3(7.0−210.3)		8	233.0(100.5−459.0)	
≥10	1,191.0	1	84.0(2.1−467.7)		5	419.8(136.0−979.8)	
unknown	1,759.3	0	0.0(0.0−209.7)		3	170.5(35.2−498.5)	
Previously treated TB				0.015			<0.001
No	6,227.8	2	32.1(3.9−115.9)		13	208.7(95.3−322.2)	
Yes	155.7	1	642.3(16.2−3,577.4)		3	1,926.8(397.6−5,632.6)	
Chronic bronchitis				0.808			0.116
No	6,081.6	3	49.3(10.2−144.2)		14	230.2(109.6−350.8)	
Yes	286.5	0	0.0(0.0−1,288.0)		2	698.1(84.5−2,520.1)	
Pneumoconiosis				0.960			0.890
No	6,366.5	3	47.1(9.7−137.8)		16	251.3(128.2−374.5)	
Yes	12.8	0	0.0(0.0−28,828.1)		0	0.0(0.0−28,828.1)	
Self-reported cigarette smoking				0.475			0.880
Never smoking	5,206.4	2	38.4(4.6−138.7)		13	249.7(114.0−385.4)	
Ever or current smoking	1,173.9	1	85.2(2.2−474.5)		3	255.6(52.7−747.1)	
Self-reported drinking				0.410			0.374
Never drinking	5,339.8	2	37.5(4.5−135.2)		12	224.7(97.6−351.9)	
Ever or current drinking	1,031.6	1	96.9(2.5−539.9)		4	387.7(105.7−992.6)	
BMI level				0.230			0.014
<18.5	295.6	0	0.0(0.0−1,248.3)		1	338.3(8.6−1,884.3)	
18.5–	3,211.8	3	93.4(19.3−273.1)		14	435.9(207.6−664.2)	
24–	2,189.2	0	0.0(0.0−168.6)		0	0.0(0.0−168.6)	
28–	683.7	0	0.0(0.0−539.7)		1	146.3(3.7−814.7)	

Note: 10 study sites: located in Zhejiang, Jiangsu, Guangdong, Shanghai, Heilongjiang, Henan, Hubei, Sichuan, Guangxi, and Yunnan. Not all total person-year for subgroups were equal because of missing data.
Abbreviations: DM=diabetes mellitus; TB=tuberculosis; BMI=body mass index.

TABLE 3. Characteristics of TB/DM patients in 10 study sites by different case finding methods, 2013–2015.

Characteristics	Bacteriologically positive TB				Active TB			
	Total (%)	Passive case finding (%)	Active case finding (%)	*P*	Total (%)	Passive case finding (%)	Active case finding (%)	*P*
No. of cases	18(100.0%)	7(100.0%)	11(100.0%)		44(100.0%)	8(100.0%)	36(100.0%)	
TB symptoms presence	9(50.0%)	7(100.0%)	2(18.2%)	0.002	31(70.4%)	8 (100.0%)	5(13.9%)	0.000
Involvement of lesion in chest imagination				0.835				0.212
1–2 lung fields	7(38.9%)	2(28.6%)	5(45.4%)		27(61.4%)	3(37.5%)	24(66.7%)	
3–4 lung fields	5(27.8%)	2(28.6%)	3(27.3%)		8(18.2%)	2(25.0%)	6(16.7%)	
5–6 lung fields	6(33.3%)	3(42.8%)	3(27.3%)		8(18.2%)	3(37.5%)	5(13.9%)	
Lower lung field involved	12(66.7%)	5(27.8%)	7(63.6%)	1.000	17(38.6%)	5(62.5%)	12(33.3%)	0.125
Both left and right lungs involved	10(55.6%)	5(27.8%)	5(45.4%)	0.367	17(38.6%)	5(62.5%)	12(33.3%)	0.125
Cavitation presence	7(38.9%)	3(42.8%)	4(36.4%)	1.000	8(18.2%)	3(37.5%)	5(13.9%)	0.117

Note: 10 study sites: located in Zhejiang, Jiangsu, Guangdong, Shanghai, Heilongjiang, Henan, Hubei, Sichuan, Guangxi, and Yunnan.
Abbreviations: DM=diabetes mellitus; TB=tuberculosis

However, in our study, low prevalence of TB symptoms was identified in all TB patients living with DM, implying that screenings based on symptom enquiry was not enough to find TB cases among DM patients. NPHSP provided a perfect opportunity for conducting active case-finding in DM patients. For known DM patients, quarterly face-to-face interviews by community doctors were required to monitor their DM treatment status. TB suspected symptom screening could be added into this interview, followed by referrals for those displaying TB symptoms to designated TB hospitals to receive TB-related examinations. For DM patients with risk factors, such as low BMI and previous treatment, periodic CXR examination should be provided for them.

This study had several strengths. First, we designed a population-based cohort study in which the prevalence and incidence rates of TB among DM patients were obtained. Second, TB diagnosis followed the designed procedure strictly. A national expert group reviewed all abnormal chest radiographs and repeated CXR examination and other tests that had been required for bacteriologically-negative TB to help with the final diagnosis. Third, strict quality control was put in place in the study. On top of internal checks, there was also external monitoring and evaluation.

This study was subject to some limitations. First, the population size was small. Although a high prevalence and incidence rates of TB were observed, a small number of TB cases were found among DM patients, and a large confidence interval was obtained. Second, all screened participants were known DM patients, most of which come from NPHSP records, and about 5% were self-reported. The accuracy of DM information mainly relies on the quality of NPHSP records and DM awareness of participants. In addition, we did not take blood glucose measurements, therefore, some real DM patients without confirmed diagnosis in study sites were likely excluded from our screening, and we could not analyze the risk of glucose levels for TB. Finally, information was reported by participants, and there could be incomplete or inaccurate reporting on influencing factors and TB symptoms.

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Preplanned Studies

Consumption of Milk and Dairy Products Among Junior High and Senior High School Students — China, 2016–2017

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Summary

What is already known about this topic?

Chinese dietary guidelines recommend an intake of milk and dairy products to be closely related to human health. Although the production capacity of dairy in China is strong, the per capita consumption of dairy products is not high.

What is added by this report?

This report showed that the consumption rate of milk and dairy products of junior high and senior high school students in China was 82.5% from 2016 to 2017. Only 44.1% of them consumed milk and dairy products every day. Only 20.4% of these students reached intake levels recommended by the *Dietary guidelines for Chinese residents (2016)*.

What are the implications for public health practice?

Milk and dairy products are a key food group in a healthy dietary pattern. To cultivate a healthy eating habit of including dairy for children and adolescents, the government, suppliers, schools, and parents need to cooperate together.

Junior high and senior high school students are in a period of rapid growth and development, and their requirements of nutrients are higher than that of adults. Milk and dairy products provide not only high-quality protein but also vital vitamins and minerals. The intake of milk and dairy products is closely related to human health (*1*–*2*). In 2017, China's milk production reached 36.55 million tons, which accounted for about 4.5% of global production, second only to India and the United States, and ranked third in the world (*3*). However, Chinese residents' milk consumption was relatively low. In 2017, China's per capita liquid milk consumption was 20.3 kg, which was about two-thirds of Japan, one-third of the United States, and one-fifth of the United Kingdom (*4*). This research aimed to analyze and describe the consumption of milk and dairy products of Chinese junior high and senior high school students from 2016 to 2017 and to encourage increasing the consumption of milk and dairy products.

The data came from *China Nutrition and Health Surveillance (2016–2017)*. The survey was a cross-sectional study and used multistage stratified random sampling method (*5*). Overall, 269 surveillance points were selected from 31 provincial-level administrative divisions (PLADs). The consumption of milk and dairy products for Chinese junior high and senior high students in the past a month were collected by questionnaires. Milk and dairy products were classified into four categories: liquid milk, milk powder, yogurt, and other milk products. SAS (version 9.4, SAS Institute Inc., Cary, NC, USA) was used to process the quantitative analyses. Chi-squared tests were performed to compare the consumption rate of milk and dairy products in different genders and areas, and on the composition ratio and the ratio of the recommended intake of dietary guidelines. Wilcoxon rank sum test was performed to test the differences of the consumption of milk and dairy products between different genders and areas. The protocol of this study was approved by the Ethical Committee of China CDC (201614).

A total of 28,451 junior high and senior high students were involved in the study, including 14,207 male students (6,808 in urban areas and 7,399 in rural areas) and 14,244 female students (6,781 in urban areas and 7,463 in rural areas). There were 13,589 (47.8%) students in urban areas and 14,862 (52.2%) students in rural areas. The average age of students was 14.9 ± 1.8 years.

Table 1 showed that the consumption rate of milk and dairy products among junior high and senior high school students were 82.5%, 81.4% for male students, and 83.7% for female students. The consumption rate was higher for female students than for male students (P<0.0001). The rates in urban and rural areas were 88.3% and 77.3%, respectively, with urban areas being significantly higher than rural areas (P<0.0001). In

TABLE 1. Consumption rate of milk and dairy products among Chinese middle and high school students in 2016–2017.

Types of milk and products	Gender						Region						Total	
	Male		Female		X^2	P	Urban		Rural		X^2	P		
	n	%	n	%			n	%	n	%			n	%
Liquid milk	8167	57.5	7918	55.6	10.4211	0.0012	8897	65.5	7188	48.4	845.4064	<0.0001	16085	56.5
Milk powder	692	4.9	926	6.5	35.2400	<0.0001	951	7.0	667	4.5	83.4034	<0.0001	1618	5.7
Yogurt	8091	57.0	9379	65.9	237.4309	<0.0001	9174	67.5	8296	55.8	409.3331	<0.0001	17470	61.4
Other milk products	552	3.9	714	5.0	21.2565	<0.0001	824	6.1	442	3.0	159.3793	<0.0001	1266	4.5
Total milk and products	11560	81.4	11919	83.7	26.2947	<0.0001	11996	88.3	11483	77.3	596.9972	<0.0001	23479	82.5

terms of the consumption rates of different types of dairy products, the consumption rates of liquid milk, milk powder, yogurt, and other milk products were 56.5%, 5.7%, 61.4%, and 4.5%, respectively. The consumption rate of liquid milk in male students was higher than that in female students (*P*=0.0012). Moreover, the consumption rates of milk powder, yogurt, and other dairy products in female students were higher than that in male students (*P*<0.0001). For all types of dairy products, their consumption rates in urban areas were all higher than that in rural areas (*P*<0.0001).

Milk and dairy products consumption were divided into 5 frequency groups: ≥1 time/day, 4–6 times/week, 1–3 times/week, <1 time/week, and non-consumption (Table 2). The percentages of different groups were 44.1%, 13.1%, 22.4%, 3.0%, and 17.3%, respectively. The highest percentage of frequency was ≥1 time/day. The percentages of frequencies of ≥1 time/day and 4–6 times/week were higher in urban areas (54.2%, 13.7%) than in rural areas (34.9%, 12.6%) (*P*<0.0001). The percentages of frequencies of 1–3 times/week, <1 time/week, and non-consumption were higher in rural areas (26.3%, 3.7%, 22.6%, respectively) than in urban areas (18.2%, 2.2%, 11.6%, respectively) (*P*<0.0001). At the frequency of ≥1 time/day, the percentages of liquid milk, milk powder, yogurt, and other dairy products were 27.6%, 2.1%, 18.7%, and 0.8%, respectively (Table 2).

Table 3 indicates that from 2016 to 2017, average daily consumptions of liquid milk, milk powder, yogurt, and other milk products of junior high and senior high school students who consumed dairy products were 173.7 g, 46.6 g, 102.7 g, and 27.0 g, respectively. The average daily consumptions of liquid milk, milk powder, and other milk products were higher in male students than in female students (*P*<0.05). The average daily consumptions of liquid milk, milk powder, and yogurt were higher in urban areas than in rural areas (*P*<0.01), while daily consumption of other dairy products in rural areas was higher than that in urban areas (*P*<0.0001). Converting all consumption of dairy products to liquid milk consumption, junior high and senior high school students consumed the equivalent of 216.0 g of liquid milk per day, with male students (222.8 g/d) consuming more than female students (209.5 g/d) (*P*<0.0001), and those in urban areas (247.2 g/d) consuming more than those in rural areas (183.5 g/d) (*P*<0.0001).

From 2016 to 2017, 16.9% of all junior high and senior high school students' milk and dairy products consumption reached the recommended intake of *Dietary guidelines for Chinese residents (2016)*, of which 17.2% were male students and 16.5% were female students, and 22.7% in urban areas and 11. 5% in rural areas, with urban areas higher than rural areas (*P*<0.0001). For students who consumed dairy products, 20.4% of them reached the recommended amount; 21.2% of them were male students and 19.6% of them were female students, where the proportion of male students were higher than that of female students (*P*<0.01); 25.7% in urban areas and 14.9% in rural areas, where the proportion of urban students was higher than that of rural students (*P*<0.0001).

DISCUSSION

This study presented that from 2016 to 2017, the consumption rate of milk and dairy products among Chinese junior high and senior high school students was 82.5%; the consumption rates in urban areas and rural areas were 88.3% and 77.3%, respectively. One study showed that in 2006, the consumption rate of dairy and dairy products among 12–17 year-old teenagers in 9 PLADs of China was 13.68%. The consumption rates among 7–17 year-old students was 38.33% in urban areas and 4.65% in rural areas (*6*). In comparison to ten years ago, although using different

TABLE 2. The distribution of milk and dairy products consumption frequency among Chinese middle and high school students in 2016–2017.

Types of milk and products	Consumption frequency	Gender						Region						Total	
		Male		Female		$\chi2$	*P*	Urban		Rural		$\chi2$	*P*		
		n	%	n	%			n	%	n	%			n	%
Liquid milk	≥1 time/day	4,172	29.4	3,673	25.8	51.9510	<0.0001	4,845	35.7	3,000	20.2	1,171.6262	<0.0001	7,845	27.6
	4–6 times/week	976	6.9	961	6.8			1,101	8.1	836	5.6			1,937	6.8
	1–3 times/week	274,2	19.3	2,958	20.8			2,702	19.9	2,998	20.2			5,700	20.0
	<1 time/week	327	2.3	393	2.8			306	2.3	414	2.8			720	2.5
	Don't consume	5,990	42.2	6,259	43.9			4,635	34.1	7,614	51.2			12,249	43.1
Milk powder	≥1 time/day	273	1.9	330	2.3	39.4260	<0.0001	351	2.6	252	1.7	101.7397	<0.0001	603	2.1
	4–6 times/week	47	0.3	78	0.6			78	0.6	47	0.3			125	0.4
	1–3 times/week	316	2.2	424	3.0			458	3.4	282	1.9			740	2.6
	<1 time/week	89	0.6	134	0.9			109	0.8	114	0.8			223	0.8
	Don't consume	13,482	94.9	13,278	93.2			12,593	92.7	14,167	95.3			26,760	94.1
Yogurt	≥1 time/day	2,474	17.4	2,854	20.0	237.5455	<0.0001	3,087	22.7	2,241	15.1	546.9763	<0.0001	5,328	18.7
	4–6 times/week	818	5.8	930	6.5			987	7.3	761	5.1			1,748	6.1
	1–3 times/week	4,135	29.1	4,867	34.2			4,484	33.0	4,518	30.4			9,002	31.6
	<1 time/week	691	4.9	748	5.3			634	4.7	805	5.4			1,439	5.1
	Don't consume	6,089	42.9	4,845	34.0			4,397	32.4	6,537	44.0			10,934	38.4
Other milk products	≥1 time/day	103	0.7	120	0.8	23.3586	0.0001	130	1.0	93	0.6	162.2505	<0.0001	223	0.8
	4–6 times/week	31	0.2	30	0.2			31	0.2	30	0.2			61	0.2
	1–3 times/week	289	2.0	376	2.6			428	3.2	237	1.6			665	2.3
	<1 time/week	171	1.2	235	1.7			279	2.1	127	0.9			406	1.4
	Don't consume	13,613	95.8	13,483	94.7			12,721	93.6	14,375	96.7			27,096	95.2
Total milk and products	≥1 time/day	6,292	44.3	6,264	44.0	43.4343	<0.0001	7,369	54.2	5,187	34.9	1,357.4860	<0.0001	12,556	44.1
	4–6 times/week	1,756	12.4	1,975	13.9			1,865	13.7	1,866	12.6			3,731	13.1
	1–3 times/week	3,145	22.1	3,236	22.7			2,479	18.2	3,902	26.3			6,381	22.4
	<1 time/week	384	2.7	465	3.3			294	2.2	555	3.7			849	3.0
	Don't consume	2,630	18.5	2,304	16.2			1,582	11.64	3,352	22.55			4,934	17.3

TABLE 3. Daily consumption of milk and dairy products by junior high and senior high school students — China, 2016–2017 (g/d).

Types of milk and products	Number of students consumed	Gender						Region						Total	
		Male		Female		χ^2	*P*	Urban		Rural		χ^2	*P*		
		Mean	SD	Mean	SD			Mean	SD	Mean	SD			Mean	SD
Liquid milk	16,085	183.3	150.5	163.9	134.8	76.64	<0.0001	189.2	149.3	154.6	133.0	334.78	<0.0001	173.7	143.3
Milk powder	4,054	47.8	56.3	45.5	55.7	5.40	0.0201	48.3	56.8	43.7	54.4	10.94	0.0009	46.6	56.0
Yogurt	17,470	105.5	117.2	100.2	105.9	3.74	0.0532	107.0	111.2	97.9	111.2	55.54	<0.0001	102.7	111.3
Other milk products	1,266	29.5	42.8	25.1	40.5	8.98	0.0027	23.0	35.7	34.6	49.9	21.43	<0.0001	27.0	41.6
Total	23,479	222.8	222.4	209.5	216.1	34.76	<0.0001	247.2	234.1	183.5	197.5	832.79	<0.0001	216.0	219.3

Abbreviation: SD=standard deviation.

methods, the consumption rate of milk and dairy products of junior high and senior high students in this study was higher. Consistent with another study (*7*), this study shows that the consumption rate of liquid milk and yogurt of Chinese junior high and senior high school students was relatively high, while the consumption rate of milk powder and other milk products was low. In 2006, the consumption rate of yogurt among children and adolescents aged 7–17 in China was only 18% of that of fresh milk (*6*). The rapid growth of yogurt consumption, on the one hand, may be related to the popularity of diverse flavors (*8*). On the other hand, for those who have lactose intolerance, yogurt is a good substitute for milk (*9*). According to surveys, the incidences of lactase deficiency among Chinese children aged 3–5, 7–8, and 11–13 were 38.5%, 87.6%, and 87.8%, respectively. The incidences of lactose intolerance were 12.2%, 32.2%, and 29%, respectively (*1*).

This study indicated that 44.1% of junior high and senior high school students consumed milk and dairy products every day. Daily consumption rate among urban students (54.2%) was significantly higher than that of rural students (34.9%). The results of "*China Nutrition and Health Surveillance (2010–2013)*" showed that the daily consumption of milk and dairy products of children and adolescents aged 6–17 was 39.2%, with 52.3% in urban areas and 24.6% in rural areas (*10*). In comparison, daily consumption rate of milk and dairy products of Chinese junior high and senior high school students has increased in the past five years, especially in rural areas. However, there still remains a gap between the *Dietary guidelines for Chinese residents (2016)* and the estimated current dairy intake of Chinese students.

According to the *Dietary guidelines for Chinese residents (2016)*, consuming 300 mL milk or equivalent dairy products daily should be ensured for school-age children. This study estimated that from 2016 to 2017, the average consumption of liquid milk among Chinese junior high and senior high students who consumed milk and dairy products was 216.0 g/d, with 247.2 g/d in urban areas and 183.5 g/d in rural areas. A relevant study showed that the average daily milk consumption of children and adolescents aged 7–17 in urban and rural areas in 2006 was 78.03 g and 7.47 g, respectively (*6*). The results of "*China Nutrition and Health Surveillance (2010–2013)*" presented that the intake of milk and dairy products of Chinese children and adolescents aged 11–17 was about 40–60 g/d in urban areas and 10–20 g/d in rural areas. The highest proportion reaching the recommended amount of Dietary Guidelines was 2.5% in the urban 11–13-year-old group, and the lowest was 0.5% in the rural 14–17-year-old group (*11*). Although the dietary survey method used in this paper differed from the above two studies, the consumption of milk products among middle and high school students in China has still likely increased in the past decade. However, there remains a gap between recommended consumption and the actual consumption.

The intake of milk and dairy products of Chinese junior high and senior high school students may be affected by regional economies, family incomes, nutritional knowledge, and eating habits (*6*). In 2000, 7 ministries, including the Ministry of Agriculture and the Ministry of Education, jointly promoted the Chinese Students Drinking Milk Program. In 2019, the State Council officially announced the *Opinions on Implementing the Healthy China Action*. It has become a national strategy and a social consensus for children to keep drinking milk every day. Considering the lunch prepared by the school, it is more reasonable to encourage both families and school teachers to pay attention to the consumption of milk and dairy products for teenagers. It is recommended that suppliers should develop milk and dairy products with diverse flavors to meet the taste needs of teenagers. Lactose free milk should also be provided for those who are lactose intolerant.

This study had some limitations. First, due to the sampling design of this study, the samples did not cover the students in the highest grades of junior high and senior high school, which could affect the randomness of the sampling. Second, the consumption of milk and dairy products adopted the method of FFQ retrospective survey, which had a certain recall bias.ideal.

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Perspectives

Optimization of the Pre-Hospital Rescue System for Out-of-Hospital Cardiac Arrest in China

Lei Hou[1,#]; Yumeng Wang[1,2]; Wenlei Wang[3]

ABSTRACT

Out-of-hospital cardiac arrest (OHCA) presents a significant public health challenge in China. A sharp contrast in survival rate after OHCA exists between China and more developed countries. Due to the short life-saving time window, emergency medical services (EMS) and bystanders peripheral to EMS are key contributors to survival after OHCA. Here we discuss limitations and challenges for current EMS in rescuing OHCA by reviewing requirements for EMS in China. We call for an updated public health-based pre-hospital rescue system that includes establishing a cardiac arrest registry, promoting a "Three Early's" campaign [early dialing of emergency hotline 120, early cardiopulmonary resuscitation (CPR), and early defibrillation], and operating a mechanism comprised of professional public health institutions (EMS, CDC, specialized disease prevention and control institutions, and health education institutions) as well as many governmental departments, such as healthcare, industry and information technology, and education, and non-governmental organizations, such as the Red Cross Society. Following the optimization of the pre-hospital rescue system and the participation of the whole population in self-rescue and mutual rescue, we believe that a dramatic improvement in OHCA survival will come about in China.

Out-of-hospital cardiac arrest (OHCA), defined as the absence of signs of circulation irrespective of whether the assessment was made by emergency medical services (EMS) or bystanders (*1*), presents a significant public health challenge in China (*2*). OHCAs — the most serious pre-hospital conditions — have various causes, both cardiac and non-cardiac (such as trauma) and often occur in the general population (*3*). Bystanders could see or hear cardiac arrest occurrence in 60%–80% of OHCA cases (*4*); however, the vast majority of OHCA patients already died by the time EMS arrived because of a general delay in the initiation of CPR after cardiac arrest. Note that 78.5% of all-cause deaths and about 70% of deaths from coronary heart disease — one of the important causes of OHCAs — occur out of hospital, according to the China Information System of Death Register and the World Health Organization (WHO) MONICA Project (monitoring of trends and determinants in cardiovascular disease). A sharp contrast in survival rate after OHCA exists between some areas of China (1.6%) and the United States (26.1%) (*5*–*6*). The Global Resuscitation Alliance believes that the survival rate can increase by 50% — based on current <1%–26.1% worldwide — with adherence to and implementing of best community-based practices (*6*).

REQUIREMENTS FOR EMS IN HEALTHY CHINA 2019–2030

Improving pre-hospital rescue system has been a component of the *Campaign of Cardiovascular and Cerebrovascular Disease Prevention and Treatment* of the *Healthy China Initiative (2019–2030)*. In 2020, nine governmental sectors, including the National Health Commission and National Development and Reform Commission, issued further guidance to promote pre-hospital EMS. The key contents and targets are shown in Table 1; in summary, the 2020 national guidance is the complement and perfection of the *Healthy China Initiative (2019–2030)*, which suggests current insufficiency in developing EMS.

Challenges for Pre-hospital Rescue System in Rescuing OHCA

EMS is a system closely linked to hospitals and healthcare centers; however, few patients suffering

TABLE 1. Key contents and targets of the pre-hospital rescue system in healthy China.

Category	Key contents of the *Healthy China Initiative (2019−2030)*	The 2025 targets of the 2020 national guidance issued by nine governmental sectors
EMS planning	Chest pain center established in each prefecture, city, and county; hospital-based stroke center developed; the “Green” channel developed to connect the pre-hospital and in-hospital treatment of chest pain and stroke	EMS center or station established in each prefecture-level city and conditional county; EMS radius achieved: ≤5 km in urban areas and 10–20 km in rural areas; EMS center as information platform of unified command and dispatch sharing healthcare information in each prefecture-level city; EMS network improved to include one EMS center and multiple hospitals or healthcare centers in urban and rural areas
Pre-hospital equipment and facilities	Emergency map for chest pain and stroke developed; AEDs provided in crowded places; One ambulance for every 50,000 people	Provision of one ambulance for every 30,000 people in prefecture-level cities (the allocation level of each county can refer to prefecture-level cities, and its base population can be increased to 300% of the county population)
EMS response	100% of 10-second EMS answering rate achieved; 5-minute departure rate of ambulances increased	The 120 emergency hotline being operated nationwide; 95% of calls being answered within 10 seconds and 3-minute departure rate of ambulances; 100% of patients with pre-hospital medical record; 98% of on-scene care rate for critical patients
EMS personnel	Personnel training strengthened and ability of disease prevention and emergency response improved	Sufficient healthcare staff guaranteed in each independent EMS center (station)

Abbreviations: EMS=emergency medical services; AED=automatic external defibrillator.

OHCA survive long enough to be admitted to a hospital. Moreover, telephone CPR (T-CPR) guidance for bystanders and advanced life support (ALS) provided by EMS remain an inaccessible link to survival for OHCA patients. T-CPR can significantly increase the rate of bystander CPR implementation and deliver greater chances of survival until ALS arrives. However, current policies on developing EMS lack the requirement of T-CPR from “120” dispatchers of the EMS, resulting in no formal pre-arrival telephone instructions given in urban Beijing (*5*). This likely contributes to the low rate of bystander CPR, which could be related to poor OHCA survival.

The survival chances of OHCA patients usually decrease dramatically as time lengthens from collapse to first CPR and is close to zero within 10 minutes. Evidence shows that the rate of discharge from hospital of live patients after EMS-witnessed OHCA from cardiac causes is 10.5%, significantly higher than 0.4% for OHCA not witnessed by EMS or bystanders (*7*). However, average EMS response time (call receipt to scene) is nine minutes in the United States compared to more than 15 minutes in China (*8*–*9*). It is difficult to reduce the average EMS response time to the ideal level, although evidence shows that this method is likely to be a fast and effective way of increasing OHCA survival (*10*). For example, this time remained 15 minutes over the period 2013–2017 in Beijing (*5*); in western China, the trend first decreased from 31.959 minutes during 1996–2000 to 13.712 minutes during 2005–2010 but increased again to 17.665 minutes during 2011–2015 (*9*).

PERSPECTIVE OF PUBLIC HEALTH EMERGENCY RESCUE SYSTEM FOR OHCA

Establishment of a Resuscitation Registry

Clear definitions and continuous measurement of performance indicators enable a collective approach to improving measures to increase the survival rate of OHCA patients. The Utstein Resuscitation Registry has been employed since 1990 for this purpose. Many countries, such as the United States and Japan, have established a nationwide or regional OHCA registration system by using the Utstein method. In China, this registry has been in operation since 2012 but only in a few cities, such as Beijing and Hangzhou, and only limited surveys of the Utstein style have been conducted, so continuing improvement in survival must start from a relatively poor basic level. Recently, the China CDC launched a pilot citywide cardiac arrest registry to enhance survival, accompanied by EMS-based T-CPR and community-based CPR training, in Xiangtan City, Hunan Province.

Initiation of the “Three Early’s” Campaign for OHCA Rescue

By calling the 120 emergency hotline early, early CPR, and early defibrillation (the “Three Early’s”) are important for increasing the chance of survival. After OHCA, prompt administration of basic life support

(BLS), including early bystander CPR, early public-access defibrillation, and a call as early as possible to the 120 hotline for guidance, combined with later ALS from the professional EMS, are key factors in a successful rescue. However, the "Three Early's" campaign, particularly early CPR and early defibrillation, has not been endorsed by the EMS and depends on the health-support environment provided by the government.

In China, the rate of bystander CPR is as low as 2.8%–11.4%. There are several ways to increase this rate. First, the improvement of national health literacy is required. The *Healthy China Initiative* has required that at least 3% of all residents to be trained with first aid certificates by 2030. Of university students who should have usually been more keen on public welfare undertakings, only 45.5% were willing to participate in CPR training (*11*). Recently, the Ministry of Education asked CPR to enter primary and secondary school classes, which has taken a big step in promoting and popularising CPR. Obstacles to CPR implementation also exist among trained people, such as lack of confidence, fear of secondary damage to patients, and legal liabilities. A survey reported that 13.7% of respondents would prosecute for liability when bystander CPR failed for family members with OHCA (*12*). Overall, people generally lack a proper understanding of OHCA and CPR. Second, public CPR training should be well organized. CPR should be designed as a mandatory course in school and pre-job training for occupations such as policing, firefighting, security, stewarding, and teaching. Public CPR training should be acknowledged as one of the important functions of professional public health institutions, including CDCs and health education institutions besides EMS centers. Third, as mentioned above, 120 hotline dispatchers, when answering an emergency call, should encourage and guide bystanders to implement CPR following identification of a suspected OHCA. Fourth, it is important that legal support is provided for professionals out of EMS and non-professionals participating in OHCA rescue. When the rescue fails, the rights and interests of rescuers should be guaranteed. For example, just released *Law for Medical Practitioners* has added an article on encouraging participation in out-of-hospital rescue from medical practitioners with failure exemption, as similar as we have suggested before (*2*). Nonetheless, it is promising for increasing cases with bystander CPR to make more OHCAs seen, heard, or monitored by using potential advanced technology, such as wearable devices to detect "early-warning" signals linked with EMS network.

The number of automatic external defibrillators (AEDs) in urban areas of China is inadequate, with almost no AEDs in most rural counties; this results in few reported cases with public-access defibrillation. To increase the access to an AED for OHCA, several approaches should be considered. First, more AED equipment must be placed in key locations where there is a greater chance of OHCA events. Second, an AED network should be built to enable the public to know the location of AEDs and connect with EMS easily. Third, the operation and maintenance of AEDs and a sufficient population with CPR training are essential.

EMS Inclusion in the Public Health System

The essence of rescuing OHCA lies in establishing and operating a public health mechanism for initiating BLS from bystanders as early as possible, thereby gaining the time window until the follow-up ALS from EMS. Links in the survival chain are related to multiple functions of different departments. For example, a 120 hotline dispatch center with emergency stations is currently under control of hospital management departments, while CPR training and AED rollout are associated with many departments such as healthcare, emergency, industry and information technology, education, transportation, housing and urban-rural development, public security, and justice. Moreover, capital investment and personnel need support from local finance and human resources departments. Therefore, the government should take responsibility for coordination and organization. The *Primary Health Care, Medicine and Health Promotion Law* has defined an emergency center (station) as one of the professional public health institutions. Alongside the EMS, other professional public health institutions, such as CDC, specialized disease prevention and control institutions, and health education institutions, should participate in this work. Enhancing survival from OHCA is a common responsibility of these government-established institutions, non-governmental organizations, such as the Red Cross Society, and the aforementioned departments.

CONCLUSIONS

Pre-hospital rescue of OHCA is the main battlefield of cardiovascular disease treatment. Bystanders have only a short time window to save OHCA victims before the EMS arrive. Optimizing EMS and enhancing the public health system by improving bystander participation represent the current best approach to increase OHCA survival.

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