ISSN 2096-7071
CN 10-1629/R1

# CHINA CDC WEEKLY

Vol. 4 No. 6 Feb. 11, 2022

CCDC weekly

中国疾病预防控制中心周报




ISSN 2096-7071

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Healthy China

# Current Progress and Challenges to Tobacco Control in China

Dong Sun[1]; Yuanjie Pang[1]; Jun Lyu[1,2,#]; Liming Li[1,2,#]

In May 2003, the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) was released (*1*), which is an event of great significance in the history of tobacco control. The FCTC was signed by China in November 2003 and entered into force in January 2006. Although some achievements in tobacco control have been made over the past 15 years, much more progress is needed. In July 2021, the WHO Report on the Global Tobacco Epidemic (Report) was released. The Report evaluates and grades implementation of the 6 most effective strategies of the Monitor, Protect, Offer, Warn, Enforce and Raise (MPOWER) tobacco control package in 61 high-income countries, 105 middle-income countries, and 29 low-income countries (*2*) (Table 1). This article summarizes current progress and challenges to tobacco control in China with reference to the Report.

## PROGRESS AND PROBLEMS OF FCTC IMPLEMENTATION

### Monitor Tobacco Use and Prevention Policies (Grade I for China)

China's monitoring of tobacco use and prevention policies were highly acclaimed and recommended in the Report (*2*). Since 1984, 9 nationally representative tobacco use surveys have been conducted in China - 6 among adults (in 1984, 1996, 2002, 2010, 2015, and 2018) and 3 among adolescents (1999, 2004, and 2013) (*3*). These surveys played critically important roles by providing data to inform policymaking.

### Protect People from Tobacco Smoke (Grade IV for China)

According to the FCTC, by 2011, China should have achieved completely smoke-free public transport, indoor workplaces, indoor public places, and other public places (*1*). However, as of publication of this article, the only complete smoking ban has been on public transport (*2*). Although more than 20 provincial-level administrative divisions (PLADs) or cities, including Beijing, Shanghai, Henan, Shenzhen, and Xi'an, have implemented comprehensive smoke-free legislation (*4*), it is apparent that reliance on sporadic, local legislation is insufficient to protect the vast majority of the Chinese population.

The prevalence of second-hand smoke exposure among Chinese aged 15 years and above was 72.4% in 2010, decreasing slightly to 68.1% by 2018 (*5*). As of December 2021, only 14% of the total population (approximately 198 million people) was protected by smoke-free laws (*4*). The Healthy China Initiative (2019–2030) set a target to have 30% of the population protected by comprehensive smoke-free laws by 2022 and over 80% by 2030, leaving a large gap between the current status and the targets (*6*).

### Offer Help to Quit Tobacco Use (Grade II for China)

Since 2015, China has actively promoted tobacco cessation services. Efforts include providing access to training for health professionals on how to help patients quit smoking, promoting brief cessation services, standardizing tobacco cessation clinics, and supporting establishment of a "12320" national quit smoking hotline (quit-line) in all PLADs.

However, the national tobacco use survey in 2018 showed that use of the cessation services was extremely low. Of those who attempted to quit smoking, only 3.2% have called quit-lines and only 4.6% used cessation drugs or visited cessation clinics (*5*). Cessation drugs have yet to be covered by basic health insurance schemes, decreasing utilization of and allocation in the cessation clinics (*7*).

### Warn About the Dangers of Tobacco (Grade I and III for China)

This strategy includes two parts. The first part is anti-tobacco mass media campaigns, and for this part, China was graded I (*2*). Nonetheless, the messaging of smoking being harmful to health is usually nonspecific and often presented in unattractive forms. Anti-tobacco mass media campaigns in China have largely

TABLE 1. The grading criteria of the implementation of the MPOWER policies and the numbers of countries reaching grade I in the Report.

| MPOWER Policies | Grades | | | | Countries reaching grade I | | |
|---|---|---|---|---|---|---|---|
| | Ⅰ | Ⅱ | Ⅲ | Ⅳ | High-income | Middle-income | Low-income |
| Monitor tobacco use and prevention policies | **Recent, representative, and periodic data for both adults and youth** | Recent and representative data for both adults and youth | Recent and representative data for either adults or youth | No known data or no recent data or data that are not both recent and representative | 46 | 31 | 1 |
| Protect people from tobacco smoke | All public places completely smoke-free (or at least 90% of the population covered by complete subnational smoke-free legislation) | Six to seven public places completely smoke-free | Three to five public places completely smoke-free | **Complete absence of ban or up to two public places completely smoke-free** | 19 | 39 | 9 |
| Offer help to quit tobacco use | National quit lines and both NRT and some cessation services cost-covered | **NRT and/or some cessation services (at least one of which is cost-covered)** | NRT and/or some cessation services (neither cost-covered) | None | 17 | 9 | 0 |
| Warn about the dangers of tobacco | | | | | | | |
| Anti-tobacco mass media campaigns | **National campaign conducted with at least seven appropriate characteristics including airing on television and/or radio** | National campaign conducted with five to six appropriate characteristics | National campaign conducted with one to four appropriate characteristics | No national campaign conducted between July 2018 and June 2020 with a duration of at least 3 weeks | 15 | 27 | 3 |
| Health warning labels | Large warnings with all appropriate characteristics | Medium size warnings with all appropriate characteristics or large warnings missing some appropriate characteristics | **Medium size warnings missing some appropriate characteristics or large warnings missing many appropriate characteristics** | No warnings or small warnings | 42 | 52 | 7 |
| Enforce bans on tobacco advertising, promotion and sponsorship | Ban on all forms of direct and indirect advertising (or at least 90% of the population covered by subnational legislation completely banning tobacco advertising, promotion and sponsorship) | **Ban on national television, radio, and print media as well as on some but not all other forms of direct and/or indirect advertising** | Ban on national television, radio, and print media only | Complete absence of ban or ban that does not cover national television, radio, and print media | 14 | 31 | 12 |
| Raise taxes on tobacco | ≥75% of retail price is tax | **≥50% and <75% of retail price is tax** | ≥25% and <50% of retail price is tax | <25% of retail price is tax | 24 | 15 | 1 |

Note: “Report” reffers to the World Health Organization (WHO) Report on the Global Tobacco Epidemic 2021.
Text in bold indicates the grades of China.
Abbreviation: MPOWER=Monitor, Protect, Offer, Warn, Enforce and Raise; NRT=nicotine replacement therapy.

not achieved the expected results. In 2018, only 36.4% of the public knew that smoking increases risk of stroke, heart disease, and lung cancer (*5*). Awareness of the health risks of smoking was particularly weak in rural areas.

The second part of the strategy is the use of health warning labels on packages of tobacco products, and for this part, China was graded III (*2*). China should have implemented effective packaging and labeling measures by 2009 (*1*). However, until 2017, the Rules on Cigarette Package Labeling in the Territories of the People's Republic of China (Rules) released by the State Tobacco Monopoly Administration (STMA) and the General Administration of Quality Supervision, Inspection, and Quarantine, were not fully in compliance with FCTC requirements and guidelines, which include, for example, the size, location, and wording of health warning labels (*1,8–9*). Chinese cigarette packages seem insistent on being "beautiful and fascinating," without using full-color pictorial warning and without describing the specific adverse health effects of tobacco. The Canadian Cancer Society released an international report in 2021 that ranked 206 countries or jurisdictions on the effectiveness of their health warnings on cigarette packages (*10*). According to the report, 134 countries or jurisdictions, covering 70% of the world's population, fulfilled requirements for pictorial warnings; China, however, ranked 136 (*10*).

## Enforce Bans on Tobacco Advertising, Promotion, and Sponsorship (Grade II for China)

The Advertising Law of the People's Republic of China (Advertising Law) revised in 2015 bans tobacco advertisements on mass media, in public places, on public transports, and outdoors (*11*). Publication of indirect tobacco advertisements through advertisements on any other goods or public service advertisements is also prohibited by the Advertising Law. However, since there is no clear definition of public places in the Advertising Law, tobacco companies can take advantage of this legal advertising loophole. The Charity Law of the People's Republic of China and Interim Measures for the Administration of Internet Advertising, released in 2016, prohibited promotion of tobacco products through charitable donations or the Internet (*12–13*). However, this law does not clearly regulate other forms of sponsorship, such as student grants and donations from other fundraising activities. Partial bans on tobacco advertising and promotion have little effect because tobacco companies can easily shift resources to forms that are not banned (*2*).

At present, there are still tobacco advertisements and promotions at sales points and Internet-based media. The national tobacco use survey in 2018 showed that the proportions of the population seeing tobacco advertisements on traditional media such as TV, billboards, posters, newspapers, and magazines decreased compared with 2010 (*5*). In contrast, the proportion seeing tobacco advertisement at sales points and on the Internet increased. About two thirds of the public has seen smoking scenes in movies or TV series, and in 2018, there were 133 WeChat official accounts for tobacco advertising detected (*14*).

## Raise Taxes on Tobacco (Grade II for China)

Raising tobacco excise taxes and prices is the single most effective strategy for reducing tobacco use, especially among adolescents and people with low-incomes. According to the guidelines for implementation Article 6 of the FCTC (*15*), a specific tax is more effective than an ad valorem tax if the specific tax is adjusted with consumer price index. Since the FCTC came into force in 2006, tobacco taxes have been raised twice in China. Tobacco tax reform in 2009 increased ad valorem tax rates at the producer price level and imposed an additional ad valorem tax at the wholesale price level. Although this adjustment increased government revenue, the higher tax amount was not passed on to consumers because STMA reduced profits at the wholesale level. As a result, cigarette sales did not decline. The 2015 tobacco tax reform raised ad valorem tax rates and levied specific taxes at wholesale prices. This adjustment resulted in a slight increase in the retail price of cigarettes on average by 11% and a 7.8% decrease in annual cigarette sales (*16*). However, cigarette sales began rising again in 2017 (*3*).

FCTC recommends that share of total taxes in retail price of the most widely sold cigarette brand should be ≥75%; in China that percentage is only 54.5% (*2*). In addition, according to the Report, cigarettes in China have become more affordable since 2010. In other words, increases in tobacco taxes did not offset inflation and income growth, leading to overall less expensive cigarettes in China. The national tobacco survey in 2018 showed that the median price paid for a pack of 20 cigarettes was 9.9 CNY, with no change compared with that in 2015 (*5*).

## CHALLENGES AND RECOMMENDATIONS

During the 15 years since the FCTC came into force in China, some progress has been made towards fulfilling the obligations. However, there are still big gaps in FCTC implementation. The root causes of these gaps are obstacles from the tobacco industry and the government's ambiguous attitudes toward the tobacco economy (*3*). The tobacco industry of China is state-owned and adopts a system of unified leadership and monopolized operation, with the STMA and the China National Tobacco Corporation (CNTC) being jointly responsible for centralized management. Until now, STMA remains a member of the Leading Group for Inter-Ministerial Coordination for the Implementation of the WHO FCTC (Leading Group). Such a situation provides an opportunity for the tobacco industry to interfere with formulation and implementation of effective tobacco control policies. For example, little progress has been made on the health warning labels which are the responsibility of CNTC/STMA. CNTC/STMA uses its influence to weaken tax policies on tobacco sales and hinder enactment of national smoking-free laws. In the context of the steady growth of China's economy, local governments are even less determined to implement tobacco control policies due to the large proportion of tobacco industry in the governments' tax revenue.

The prevalence of smoking among people 15 years and older in China was 26.6% in 2018 - almost unchanged from 2010 (*5*). Healthy China 2030 set a smoking prevalence target of 20% by 2030 (*17*). However, the target will be challenging to achieve without removing obstacles from the tobacco industry. An enormous structural change should start by removing CNTC/STMA from the Leading Group. After that, several recommendations for better implementation of the FCTC can be considered, including the following: 1) enacting a national smoke-free law, without any exceptions or legal loopholes; 2) having smoking cessation services covered by basic health insurance schemes; 3) putting large pictorial health warnings on all tobacco packages; 4) strengthening regulation of tobacco advertising and promotions on the Internet and sales points and strengthening regulation of smoking scenes in movies and TV series; and 5) adopting stronger and more effective tax and price measures by relying more on a uniform specific taxes that is regularly increased in line with inflation.

In conclusion, changes must be made top-down to remove all the obstacles described above. The Healthy China 2030 blueprint puts health at the center of the country's entire policymaking machinery and requires implementing health in all policies (*17*). Fulfillment of FCTC obligations is the best way to put into practice the core principles of Healthy China 2030.

**Conflicts of interest**: No conflicts of interest.

**Funding:** Reforming the Public Health Preparedness and Response of China: from Evidence to Policy Recommendations. China Medical Board (20-366).

**doi:** 10.46234/ccdcw2022.020

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Submitted: January 06, 2022; Accepted: February 08, 2022

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Perspectives

# Application of Blockchain in Trusted Digital Vaccination Certificates

Zixiong Zhao[1]; Jiaqi Ma[1,#]

With the increasing number of coronavirus disease 2019 (COVID-19) cases and worldwide vaccination coverage, ‘vaccination passports’ (vaccination certificates) may become a required permit for global travel, thereby supporting economic recovery. On March 7, 2021, Wang Yi, State Councilor and Foreign Minister of China, announced the launch of the Chinese version of an ‘international travel health certificate’ at a press conference of the National People’s Congress and the Chinese Political Consultative Conference. He proposed a feasible ‘Chinese solution’ for promoting the recovery of the global economy and the facilitation of cross-border travel, and hoped that the international travel health certificate and vaccination passport can be mutually authenticated. The Israeli government issued a vaccination certificate or ‘green passport’ to vaccinees via a smartphone application and the government website, which must be presented when entering places with a high risk of infection such as restaurants and cultural facilities. The European Union (EU) plans to introduce an EU vaccination certificate by the summer of 2021 that includes vaccination records and nucleic acid test results. The government of the Republic of Korea is exploring the implementation of a COVID-19 vaccination passport by issuing vaccination passports to Korean citizens and exempting arriving foreigners with vaccination passports from quarantine.

Mutual trust of electronic vaccination certificates is important to promote the implementation of vaccination passports. The World Health Organization (WHO) issued interim guidance for developing a smart vaccination certificate (hereafter referred to as the guidance) in March 2021 (*1*), and created the concept of digital vaccination certificates (DVCs) or ‘smart vaccination certificates’ (SVCs). The purpose of SVCs is to provide a mechanism for individuals to submit documents proving that they have been vaccinated, and the certificate can be encrypted and verified by the authorities. SVCs are considered superior to paper vaccination certificates that may be defrauded, lost, damaged, or difficult to read due to illegible handwriting. SVCs were designed for COVID-19 vaccines, but the aim is to establish a basic consensus mechanism applicable to other vaccines in the future. Following the guidance, in this work we propose a technical route for the application of blockchain, the underlying technology of Bitcoin, in trusted DVCs.

## PROBLEMS AND CHALLENGES IN VACCINE AND VACCINATION INFORMATION MANAGEMENT

Inconsistent development in the digitalization of immunization programs in different countries poses problems and challenges to existing vaccination information systems, as follows: 1) Information on vaccine production is usually generated unilaterally by vaccine license holders using traditional information technology; it is difficult to verify the authenticity of sources and the integrity of content, and there is a risk of tampering and fabrication; 2) Cold-chain distribution of vaccines is mainly self-monitored by logistics enterprises with insufficient external supervision, lacking automated collection and certification of information on personnel, equipment, temperature, and time spent in the transportation process; 3) The lack of a mechanism by which records are made by persons in charge during the circulation and use of vaccines makes it difficult to verify the authenticity of information; and 4) traditional centralized vaccine management information systems suffer from poor data access and vulnerability to single point failures, which makes it difficult to ensure information sharing and the availability of third-party inquiry services.

## BLOCKCHAIN AND ITS APPLICATION

In recent years, blockchain has gained worldwide attention and is widely used in digital currency, financial credit reporting, and supply chain management. Blockchain employs a distributed storage system to ensure the authenticity and integrity of information, uses consensus algorithms to establish fault-tolerant mechanisms, deploys and validates smart contracts to avoid transaction risks, and issues workload certificates to encourage user participation. Blockchain has great potential for application in vaccine tracking. Making full use of blockchain technology allows decentralization of immunization program information systems, better protection of vaccine safety and vaccination data, and tracking/managing the whole process of vaccine deployment. The combination of blockchain, the internet of things, and artificial intelligence in DVC systems provides the technical means to promote the recovery of the global economy and to facilitate the cross-border movement of people. The practical significances of trusted DVCs or SVCs based on blockchain technology are shown in the following paragraphs (*2*).

The first is authentic and valid data storage. Distributed data storage with blockchain is characterized by tamper-proof data and non-repudiation. Asymmetric encryption can be used to achieve mutual trust of vaccination information between nodes. Meanwhile, signature/verification mechanisms make vaccination information undeniable. Based on the consensus among blockchain nodes and cryptographic principles, a tamper-proof record of malicious acts in a node is created and broadcast throughout the network.

The second is safe and reliable information transmission. The cross-border authentication of DVCs or SVCs is prone to frequent disruption of information transmission. The consensus mechanism of blockchain can be used to obtain authentic and valid information. As long as the destruction is controlled to some extent (less than 50% of the computing power of the entire network), cross-validation between user nodes can be carried out based on the consensus mechanism to achieve the verification and accurate transmission of information and to improve the reliability of network information.

The third is autonomous and flexible application mechanisms. Blockchain shortens the delay of intermediate processes and increases the speed of response through fast network computing. With the application of DVCs or SVCs, artificial intelligence will also be widely used in verification systems. Consensus algorithms can be combined with swarm intelligence to create application modes suitable for the specific conditions of various countries.

The fourth is trusted and interconnected network architectures. In the guidance, the WHO proposed the construction of a trust framework consisting of technical specifications, interoperability standards, and related governance mechanisms to establish a consensus mechanism agreed upon by multiple entities (countries or regions), and to build a stable and reliable blockchain network as a key factor to ensure the implementation of this trust framework. The trust framework of global DVCs or SVCs consortium blockchain established by the WHO aims to provide a consensus mechanism at the technical level. Based on the consensus, any member country can trust that DVCs or SVCs issued by another member country are authentic and tamper-proof. Meanwhile, the WHO has developed and provided worldwide cross-chain relay services (*3*).

## SCENARIOS FOR BLOCKCHAIN APPLICATION IN DVCs

The first scenario is control and protection of key information. DVCs represent a basic component of vaccination tracking. Combining digital and traditional management of vaccines and vaccination and maintaining the integrity of vaccination certificates are essential to the functioning of DVCs. The control and protection of key information are mainly reflected in two application scenarios: 1) continuity of vaccination: a vaccination record is a dynamic documentation of vaccination and an important part of individual medical records that provides vaccination information to healthcare workers as part of individual health records; 2) certificate of vaccination: the certificate of vaccination is a document that records and proves individual vaccination. DVCs are typically deployed and operated on regional digital health information platforms. Centralized data in DVC systems are vulnerable to attacks. The security level of original data recorded in DVC systems can be elevated by adopting blockchain technology. This ensures that all information is accurate, valid, tamper-proof, and largely isolated from external threats (*4*). Meanwhile, cryptographic technologies used in blockchain can automate the safe storage and transmission of key data and reduce the cost of safety regulation and communication networks connecting organizations and institutions (*5*). The process of vaccination data transmission based on blockchain technology is shown in Figure 1.

The second scenario is collaborative recording of vaccination certificate information. Traditional vaccination certificate information is usually recorded separately (production code, cold-chain storage, cold-chain transportation, and vaccination), then uploaded to different information management systems. Information on vaccine production, circulation, and use is isolated, and management nodes control information from independent systems, making it difficult to achieve zero trust for tamper-proof information. The decentralized, distributed ledger of blockchain publicly records all key information for vaccines in a distributed ledger through encryption, which greatly increases the cost of information tampering and makes it suitable for guaranteeing the authenticity and credibility of data from the whole process of vaccine deployment. Tracking DVCs is supported by consortium blockchain technology that provides traceable and tamper-proof data storage, smart contracts that can be developed and called on demand, a non-repudiable signature mechanism based on asymmetric cryptography, and decentralized system architecture. Blockchain can provide a basis for the interaction and intelligent coordination of vaccine planning and distribution, cold-chain logistics monitoring, stock-in/stock-out management, and vaccination information recording. The principles of collaboration in trusted vaccination certificate information based on smart contracts is shown in Figure 2.

The third scenario is cross-domain user digital identity authentication. Digital identity authentication based on the smart contract of blockchain provides digital identity authentication with a private key and encryption with a public key for all participating entities (i.e., all cross-domain users involved in the collaboration or verification of the entire process of vaccination). An unclassified world wide web consortium (W3C) decentralized identifier (DID) is assigned to each participating entity (*6*) via blockchain-enabled self-generated identity keys, bound to public

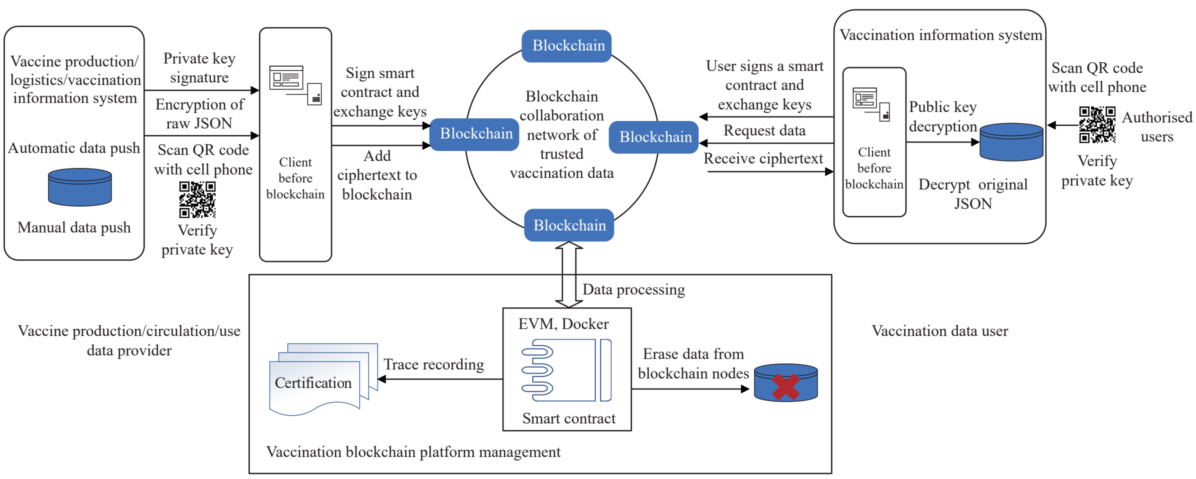


FIGURE 1. Blockchain-based vaccination data transmission.
Abbreviations: JSON=JavaScript Object Notation; QR code=Quick Response Code; EVM=Ethereum Virtual Machine.

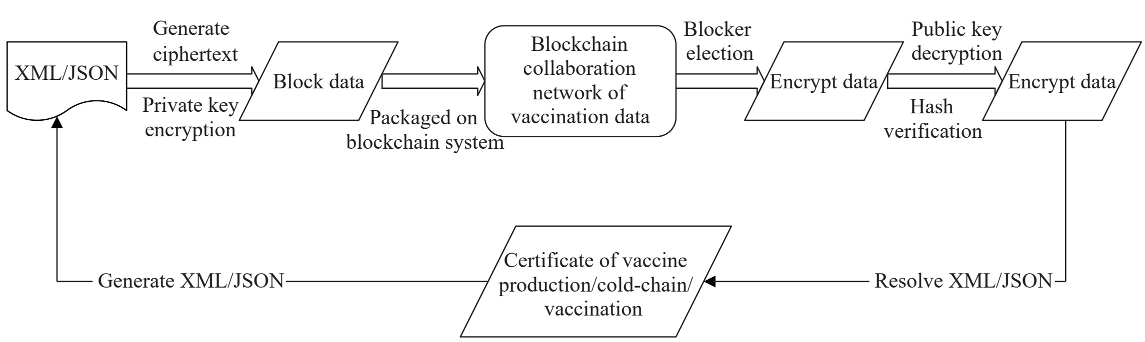


FIGURE 2. Principles of collaboration in trusted vaccination certificate information based on smart contracts.
Abbreviations: XML=EXtensible Markup Language; JSON=JavaScript Object Notation.

keys and other unencrypted metadata in shared documents, and kept unchanged. The key is distributed across all participating user network nodes through blockchain ledger without the use of a third-party digital certificate authority (CA), which provides a common, domain-wide root of trust for digital identity and public key encryption (PKE). All user entities have service terminal nodes on the blockchain collaboration network of trusted vaccination data. The vaccine production data, cold-chain logistics monitoring data, vaccination data and adverse events following immunization (AEFI) data are asymmetrically encrypted and added to blockchain for distribution through cross-domain client application software. In addition, encrypted documents for collaborative transactions can be accessed from blockchain via client application software. The digital identity verification process based on blockchain smart contracts is shown in Figure 3.

## CHALLENGES AND COUNTERMEASURES OF ‘BLOCKCHAIN+’ DVCs

Due to the special requirement of vaccination data security, most vaccination information has different levels of protection. Therefore, information storage encryption must be strictly controlled by blockchain. To address this challenge, the peer-to-peer nature of nodes can be partly sacrificed to construct a polycentric rather than peer-to-peer blockchain, network nodes can be appropriately managed in a hierarchical manner, and the level of vaccination information protection can be matched with the level of confidentiality of information stored in the blockchain. The WHO should be driven to establish a globally trusted SVC consortium blockchain to achieve polycentric trust and consensus.

Blockchain has a distributed network structure with frequent information exchange and requires high communication bandwidth between nodes, which might not be met by traditional communication approaches. The nodes also have high demand for hardware, such as large-capacity memory and high-performance central processing units (CPUs), to ensure efficient information transfer. Balancing performance and cost requires powerful communication equipment where possible. It is possible to reduce the overall pressure on network communication by designing super nodes as communication agents for ordinary nodes and concentrating a large amount of communication traffic on a small number of links, but this will inevitably compromise the robustness of the network structure.

Large node size delays smart contract processing, reduces the overall performance of the network, and affects the efficiency of information exchange. Since collaborative vaccination information verification requires real-time information transmission, processing speed and throughput are two factors limiting the performance of blockchain. This can be addressed by using 5G network mobile process calculi, which splits a transaction into problem sets in the case of frequent out-block operations of on-chain data, and each node handles only one small fragment transaction related to its specific needs. Small fragments are assembled to larger fragments and eventually a complete transaction.

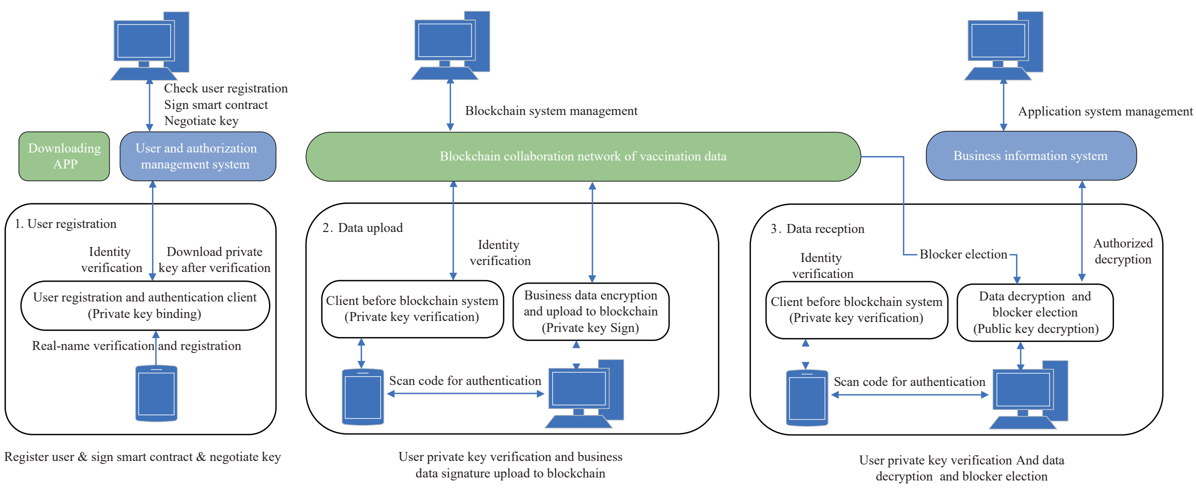


FIGURE 3. Mechanism of blockchain identity digital authentication based on smart contracts.

In summary, combining blockchain with DVCs has great potential for a range of applications, but defense against malicious cyberattack is a key concern. It is necessary to strengthen the development and supervision of technologies underpinning blockchain so that the performance can meet global application standards. In addition, through deep integration with other information technologies, the operation efficiency of the whole system can be improved while overcoming the shortcomings of blockchain. Implementation of WHO guidance in China requires the development and publication of unified data element standards and format standards for DVCs and SVCs as soon as possible, as well as further clarification of the public key application technical standards and open-source software development kit (SDK) based on blockchain technology, and detailed technical guidelines for implementation. Countries should be encouraged to adopt international open-source blockchain and networking technologies. The WHO should be driven to select appropriate regions or countries to set up cross-chain relay service sites, to establish globally trusted consortium blockchain processes, to unify encryption algorithms, and to establish smart contracts to add DVCs to blockchain for certification and mutual trust/consensus.

**Conflicts of interest**: No conflicts of interest reported.

**Acknowledgements**: All participants of the standard "Baseline for vaccine traceability blockchain application".

**Funding:** Study on harmonization platform for big data of population health and paradigm of scientific research and managerial decision-making driven by big data (National Natural Science Foundation of China, 91846303).

**doi:** 10.46234/ccdcw2022.021

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Submitted: August 01, 2021; Accepted: November 11, 2021

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Commentary

# Calibrations of Urbanization Level in China

Yang Wang[1]; Jinfeng Wang[1,2,#]; Yansui Liu[3]; Jie Li[1]

Urbanization is the inevitable outcome of socioeconomic development, especially after the industrial revolution in 1760 (*1*). Since the founding of the People's Republic of China in 1949, the urbanization of China has made great progress. The speed and mass of urbanization and notably its relevant consequences, such as resource consumption and carbon emissions, has taken place in the most populous country in the world over the past three decades, which is raising increased concerns internationally (*2*) (Figure 1). Urbanization rate (in this article, this indicator refers to the population urbanization rate) is a common indicator of urbanization. Many international organizations (such as the World Bank, World Health Organization, Food and Agriculture Organization of the United Nations, etc.) use urbanization as one of the important criteria for measuring productivity and economic growth in a country (*1*). China's urbanization process can be described as the largest population migration in history and has also had an important impact on public health. As the national population migrates from rural to urban areas, differences in lifestyle, environmental quality, social security, and accidental injuries have all been brought about and become more and more dramatic (*3*). Therefore, as an important socioeconomic factor, the urbanization rate index also has an important reference role in the measurement and evaluation of public health, and the accuracy of the index is also particularly important.

An urbanization rate of 50% is a key point in assessing the development level of urbanization, which is an important symbol of a country (or region) developing into an urbanized country or achieving modernization. It represents a historical change in the social structure and the mode of production (*4*).

However, the calibration of urbanization rate varies in time and changes for different regions and departments due to a multitude of reasons, which makes the rate problematic to capture. Conceptually, the universal urbanization rate refers to the urbanization rate of residential populations, and the calculation method is taking the ratio of the urban population to the residential population (*5*). The residential population is a common statistical caliber concept of the population census at home and abroad, which refers to the population who often resides in a certain area and can be divided into the urban population and the rural population according to their attribute of living (*6*). Furthermore, due to China's unique permanent residence registry system ("hukou") (*3*), registered population is another common statistical concept. Registered population is the population who has registered a permanent residence and is divided

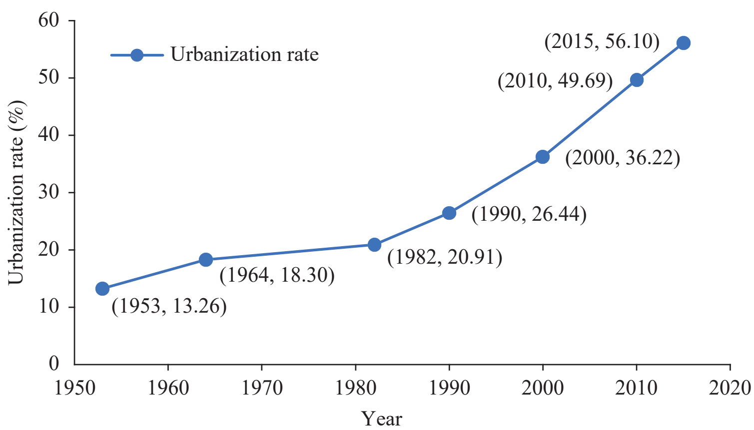


FIGURE 1. The changes in China's urbanization rate (at different year of Chinese Population Censuses and the Statistical Bulletin of the Economic and Social Development in 2015).
Data sources: Data from the 1953, 1964, 1982, 1990, 2000, and 2010 Population Censuses of China and the Statistical Bulletin of the Economic and Social Development in 2015.

into agricultural population and non-agricultural population according to the property of registered residence (*7*). The urbanization rate of the registered population was first proposed in 2014 (*8*). Prior to this, the proportion of non-agricultural population under the registered population system has often been used to represent urbanization rate.

The two urbanization rate indicators under different demographic systems used in the calculation of urbanization have brought about some problems.

The first problem is that urbanization rates are not comparable for different demographic systems. There is a wide variety of statistical data in China that use different demographic systems. Consequently, the urbanization rate indicators in these statistics cannot be used simultaneously. If there is a mandatory comparison of the urbanization rate of different demographic systems, overestimation or underestimation will occur (Figure 2).

The second problem is that urbanization rates are less comparable in time series. With the development of urbanization, changes in the concept of statistical indicators coupled with the adjustment of administrative divisions directly resulted in changes in statistical calibers, which has had some impacts on the statistical results. This in turn influenced urbanization rates on time series even under the same demographic system. Therefore, if the same statistical caliber is used to calculate the urbanization rate for a certain time series, the result will be incomparable (Figure 3).

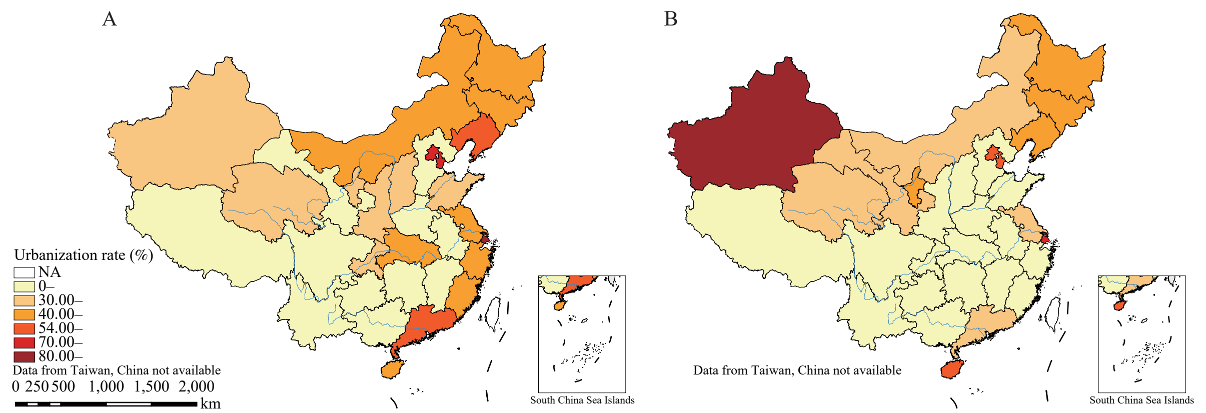


FIGURE 2. Urbanization rates under different demographic systems. (A) The proportion of urban population in 2000 National Population Census; (B) The proportion of non-agricultural population in 2000 China City Statistical Yearbook.
Data sources: the 5th Census Data (2000) and 2000 China City Statistical Yearbook. The two maps present significant difference (Geodetector *q*=0.46***).
Abbreviation: NA=not available.

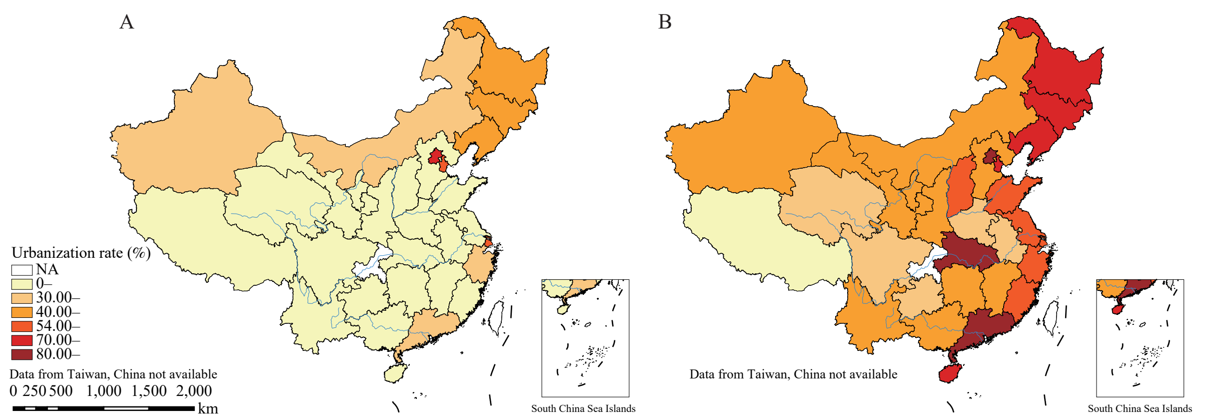


FIGURE 3. Urbanization rate of residential population calculated under different urban population statistical calibers. (A) 1990 urbanization rate in National Population Census (calculated under 1990 urban statistical caliber); (B) 1990 urbanization rate in National Population (calculated under 1982 urban statistical caliber).
Data Sources: the national population census data in 1982 and 1990 Population Census of China. The two maps present significant difference (Geodetector *q*=0.36***).
Abbreviation: NA=not available.

Similarly, for smaller statistical units, changes in urbanization rate-related indicators caused by the adjustment of administrative divisions also made it difficult to study the time series of urbanization rates (Figure 4).

Although China's current residential urban population statistical caliber basically conforms to the current internationally accepted principles and standards for urban-rural division, the urbanization rate is still highly controversial in China.

The ambiguity of China's urbanization rate has led to uncertainty in evaluating the level of urbanization and was subject to biases in urbanization-based policies.

First, the level of urbanization reflected by the urbanization rate calculated under the two demographic systems is different. As mentioned previously, an urbanization rate of 50% is the critical point in the classification of developing and developed countries. By the end of 2017, the urbanization rate of residential population in China was 58.52%, while the urbanization rate of registered population was 42.35% (*9*). The gap between the urbanization rates under the two demographic systems will lead to some bias in judging and explaining the critical stages of social development.

Second, the permanent residence registry system exists in countries worldwide. It is a sign that the state recognizes and protects the legitimate rights and interests of the registered persons according to law. In China, the permanent residence registry system is a unique urban-rural dualistic household registration system (hukou system) (*9*), which is different from other countries, and the nature of the hukou is legal evidence for resource allocation and benefit distribution. Although the reform of the household registration system promoted by some cities and regions in China has somewhat weakened the classification of people in the household registration system, the hukou-related phenomenon is still a hidden existence. Taking Shanghai as an example, in 2013, the residence permit points system was first implemented. The migrant population with a residence permit and a total score of 120 points can enjoy public service treatment such as public education, off-site college entrance examination, social insurance, housing, basic public health, etc. (*10*). However, due to the low level of education in a large number of migrant workers, this academically-based point standard makes it difficult for migrant workers to meet the household registration standards (*11*). The bundling of the household registration system and the employment system also imposes various restrictions on the occupational access of migrant workers. Coupled with the limitations of the quality of migrant workers, they can only work at the bottom of the city and encounter problems such as different pay for equal work. This has also led to a labor shortage in recent years (*11*). The gap between the urbanization rates under two demographic systems in China is the statistical representation of this phenomenon, and the essence of this problem is the "peri-urbanization" traits of China's urbanization (*12*).

Third, the incompatibility of the urbanization rates in time series and different demographic systems brought difficulties to data acquisition and judgment of the urbanization level in urbanization studies, especially when long time series are involved.

In previous studies, some scholars pointed out that the urban-rural income gap and the urbanization rate showed an inverted U-shaped relationship, which is consistent with the inverted U-shaped theory of the Kuznets curve (*13*). This means that with the increase of urbanization rate, the income gap between urban and rural residents will increase first and then decrease. The income gap between urban and rural residents has important significance in evaluating government work performance and government macro-control, and the urbanization rates under two different demographic systems will lead to different results in measuring the urban-rural income gap. In recent years, the Chinese government has begun to pay attention to the simultaneous improvement of the two urbanization rates, at the same time, the urbanization rates under the two demographic systems have been included in the work objectives. This move is also aimed at reducing the gap between the urbanization rates under the two demographic systems in measuring the degree of development and the people's living standards.

Similarly, the environmental problems brought about by the rapid development of urban economy are also closely related to the urbanization rate. For example, in recent years, the Chinese people have suffered from fog and haze. Some scholars have shown that when the urbanization rate is at a low level (less than 60.8%), fog and haze pollution gradually increase with the improvement of the economic development level. When the economic development level reaches a certain level, the fog and haze pollution goes from high to low. When the urbanization rate is at a high level (greater than or equal to 60.8%), with the further increase of the economic development level, the fog and haze pollution has turned upwards. This overall process presents an N-type relationship (*14*). Therefore, when judging the trend of fog and haze pollution through the level of urbanization reflected by

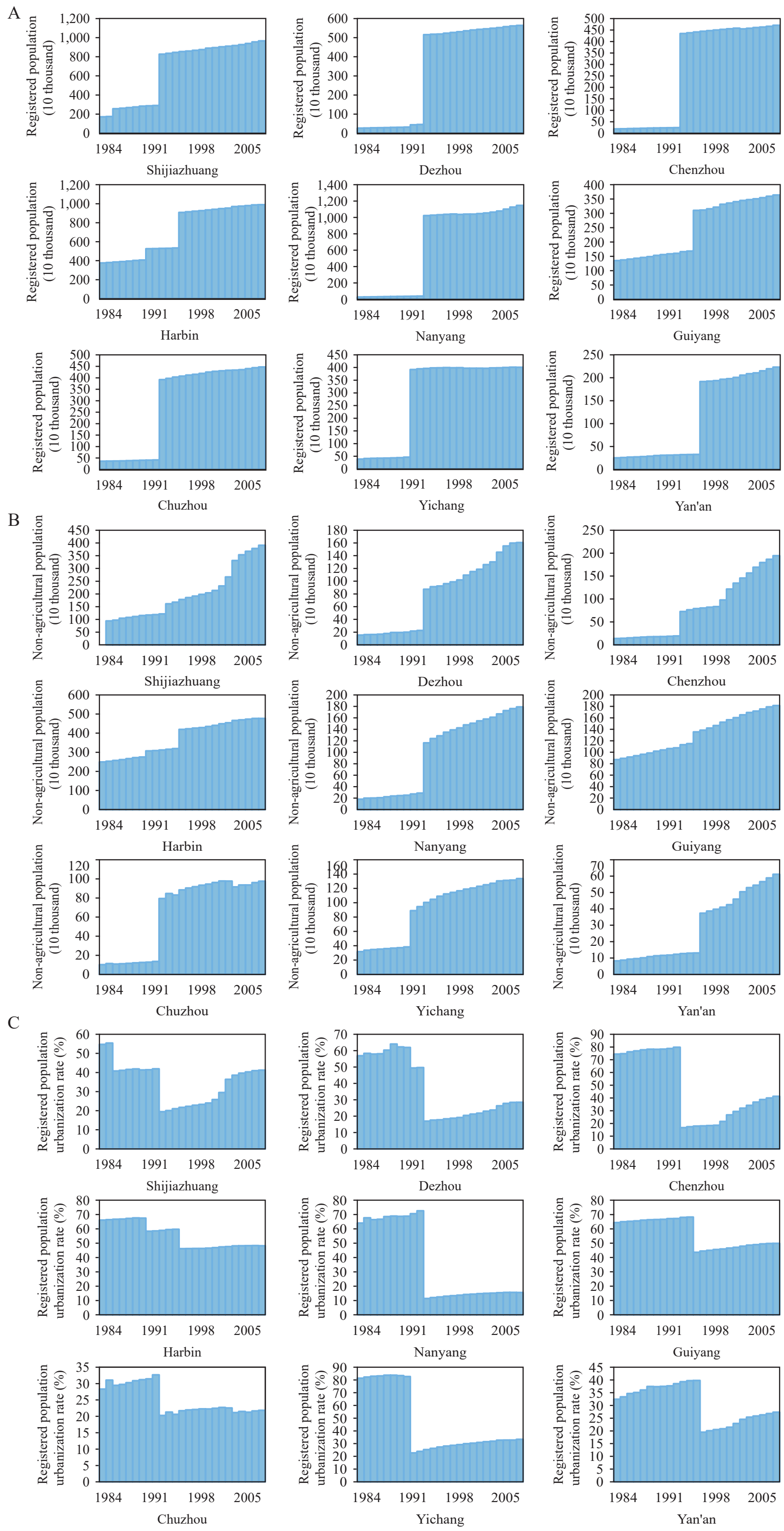


FIGURE 4. The impact of administrative division adjustment on statistical caliber. (A) The changes of registered population from 1984 to 2008; (B) The changes of non-agricultural population from 1984 to 2008; (C) The changes of registered population urbanization rate from 1984 to 2008.

Notes: According to the characteristics of statistical data and the spatial distribution of cities, here we select 9 cities which are greatly affected by the administrative division adjustment as the example cities to show the changes of statistical data.

Data sources: 1984–2008 China Urban Statistical Yearbook.

the urbanization rate, the existence of two demographic systems will bring certain ambiguity and confusion, which will affect the fog and haze governance and industrial structure development.

Joseph Stiglitz, American economist and Nobel laureate, believes that there are two things that affect human development and change the world in the 21st century: one is the development of the US high-tech industry, and the other is the urbanization of China. China is one of the most important economies in the world and has nearly one-fifth of the world's population, which has a major and long-term impact on the world. In the last few decades, China's ties with the world have become much closer, such as the Belt and Road Initiative, the Shanghai Cooperation Organization, etc., which has made China's spillover on the world more obvious. Moreover, China's urbanization is experiencing a period of rapid development, and the two urbanization rates have brought ambiguity to the evaluation of China's urbanization level. Therefore, in the comparative study of urbanization around the world, the differences of China's urbanization rates under the two demographic systems also need to be considered.

## SUGGESTIONS

When using urbanization data, we need to pay special attention to the aspects such as the different demographic systems, adjustments of the statistical caliber, the updated significance of statistical indicators, the development level of urbanization, as well as the actual administrative divisions and policy changes.

When using the urbanization data for a single year or a single region, it is necessary to ascertain whether the statistical system, statistical concept, and statistical caliber of the urbanization data in the selected statistics are the same.

In the time series comparison and basic horizontal comparison studies, the data cannot be used directly. The most basic principle is to ensure the unity of data sources. It is also necessary to pay attention to the different effects of the old and new urban population statistical caliber on urbanization data and combine them with the specific urban composition and development of different regions to revise the local urbanization rate if necessary.

It is worth developing a system of coherent of urbanization rates in China which are comparable in time, regions, and organizations.

**Funding:** Supported by the National Natural Science Foundation of China (Grant No.: 42071375).

**doi:** 10.46234/ccdcw2022.007

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Submitted: June 12, 2021; Accepted: December 10, 2021

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Notifiable Infectious Diseases Reports

# Reported Cases and Deaths of National Notifiable Infectious Diseases — China, December 2021

| Diseases | Cases | Deaths |
|---|---|---|
| Plague | 0 | 0 |
| Cholera | 0 | 0 |
| SARS-CoV | 0 | 0 |
| Acquired immune deficiency syndrome* | 7,490 | 2,486 |
| Hepatitis | 133,390 | 57 |
| Hepatitis A | 1,068 | 0 |
| Hepatitis B | 108,157 | 42 |
| Hepatitis C | 20,895 | 11 |
| Hepatitis D | 37 | 0 |
| Hepatitis E | 2,369 | 3 |
| Other hepatitis | 864 | 1 |
| Poliomyelitis | 0 | 0 |
| Human infection with H5N1 virus | 0 | 0 |
| Measles | 97 | 0 |
| Epidemic hemorrhagic fever | 2,402 | 26 |
| Rabies† | 8 | 20 |
| Japanese encephalitis | 4 | 0 |
| Dengue | 3 | 0 |
| Anthrax | 18 | 0 |
| Dysentery | 2,807 | 1 |
| Tuberculosis | 61,788 | 168 |
| Typhoid fever and paratyphoid fever | 487 | 0 |
| Meningococcal meningitis | 10 | 0 |
| Pertussis | 2,254 | 0 |
| Diphtheria | 0 | 0 |
| Neonatal tetanus | 1 | 0 |
| Scarlet fever | 3,983 | 0 |
| Brucellosis | 4,919 | 0 |
| Gonorrhea | 11,264 | 0 |
| Syphilis | 42,321 | 3 |
| Leptospirosis | 39 | 1 |
| Schistosomiasis | 4 | 0 |
| Malaria | 72 | 1 |
| Human infection with H7N9 virus | 0 | 0 |
| COVID-19§ | 3,490 | 0 |
| Influenza | 249,046 | 2 |
| Mumps | 10,892 | 0 |

Continued

| Diseases | Cases | Deaths |
|---|---|---|
| Rubella | 158 | 0 |
| Acute hemorrhagic conjunctivitis | 2,513 | 0 |
| Leprosy | 30 | 1 |
| Typhus | 91 | 0 |
| Kala azar | 25 | 0 |
| Echinococcosis | 327 | 0 |
| Filariasis | 0 | 0 |
| Infectious diarrhea[¶] | 82,512 | 0 |
| Hand, foot and mouth disease | 74,421 | 1 |
| **Total** | 696,866 | 2,767 |

* The number of deaths of acquired immune deficiency syndrome (AIDS) is the number of all-cause deaths reported in the month by cumulative reported AIDS patients.

[†] Among the 20 death cases, 3 deaths were reported in December 2021, the other were reported before.

[§] The data were from the website of the National Health Commission of the People's Republic of China.

[¶] Infectious diarrhea excludes cholera, dysentery, typhoid fever and paratyphoid fever.

The number of cases and cause-specific deaths refer to data recorded in National Notifiable Disease Reporting System in China, which includes both clinically-diagnosed cases and laboratory-confirmed cases. Only reported cases of the 31 provincial-level administrative divisions in the mainland of China are included in the table, whereas data of Hong Kong Special Administrative Region, Macau Special Administrative Region, and Taiwan are not included. Monthly statistics are calculated without annual verification, which were usually conducted in February of the next year for de-duplication and verification of reported cases in annual statistics. Therefore, 12-month cases could not be added together directly to calculate the cumulative cases because the individual information might be verified via National Notifiable Disease Reporting System according to information verification or field investigations by local CDCs.

**doi:** 10.46234/ccdcw2022.016

Indexed by PubMed Central (PMC), Emerging Sources Citation Index (ESCI), and Chinese Scientific and Technical Papers and Citations

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The inauguration of *China CDC Weekly* is in part supported by Project for Enhancing International Impact of China STM Journals Category D (PIIJ2-D-04-(2018)) of China Association for Science and Technology (CAST).

CCDC weekly

Vol. 4 No. 6 Feb. 11, 2022

**Responsible Authority**

National Health Commission of the People's Republic of China

**Sponsor**

Chinese Center for Disease Control and Prevention

**Editing and Publishing**

China CDC Weekly Editorial Office

No.155 Changbai Road, Changping District, Beijing, China

Tel: 86-10-63150501, 63150701

Email: weekly@chinacdc.cn

**CSSN**

ISSN 2096-7071

CN 10-1629/R1