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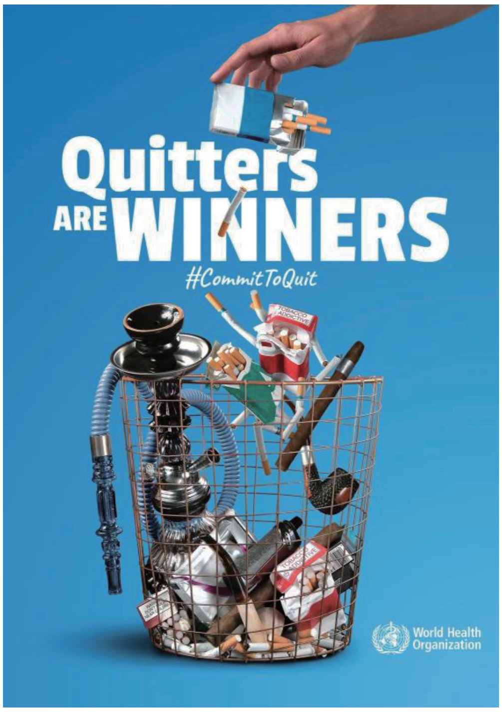

Commentary

Preplanned Studies

ISSN 2096-7071

Commentary

Achieving the Goals of Healthy China 2030 Depends on Increasing Smoking Cessation in China: Comparative Findings from the ITC Project in China, Japan, and the Republic of Korea

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Summary

Tobacco smoking is the number one preventable cause of disease and death in China as it is globally. Indeed, the toll of smoking in China is much greater than its status as the world's most populous country. There is a persistent and continuing need for China to implement the measures specified in the global tobacco control treaty, the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC), which China ratified in 2005. The theme for the 2021 WHO World No Tobacco Day focuses on the need to support smoking cessation. This article presents findings from the International Tobacco Control (ITC) Policy Evaluation Project cohort surveys in China, in comparison to ITC cohort surveys in two neighboring countries: Japan and the Republic of Korea. These findings demonstrate that smokers in China very much want to quit, but these intentions are not being translated into quit attempts, relative to smokers in Japan and the Republic of Korea. Additionally, about 80% of Chinese smokers want the Chinese government to do more to control smoking. These findings reaffirm the need for China to implement strong, evidence-based measures to reduce smoking. The objective of Healthy China 2030 to reduce deaths from non-communicable diseases by 30% can be achieved by reducing smoking prevalence from its current 26.6% to 20%, and this reduction can be achieved through strong implementation of FCTC measures.

The devastation caused by smoking in China is monumental. According to the Global Burden of Disease Study (*1*), in 2017, smoking caused 2.2 million deaths among smokers and an additional 0.4 million deaths among non-smokers due to secondhand smoke, with the total of 2.6 million deaths establishing smoking as the leading cause of death in China. The magnitude of the death and disease caused by smoking in China far exceeds China's position as the most populated country in the world: although China represents 18.5% of the global population, it suffers one-third of annual global deaths from smoking (7.1 million) and secondhand smoke (1.2 million) (*2*). The economic cost of smoking is also extraordinary, estimated to be as high as 368 billion CNY (*3*).

The goal of Healthy China 2030 is to reduce non-communicable diseases (NCD) deaths by 30%. But this cannot be achieved without great reductions in smoking. China has taken the critically important step of incorporating tobacco control into the Healthy China 2030 plan, but it is important to take strong action to achieve these dramatic reductions in smoking. Fully implementing the key demand reduction measures of the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) — higher taxes; comprehensive national smoke-free laws; large pictorial warnings on cigarette packs; strongly enforced comprehensive bans on tobacco advertising, promotion, and sponsorship; and support for cessation (demand-reduction strategies that correspond to the WHO's MPOWER* measures) (*4*) — is strongly associated with reductions in smoking prevalence (*5*). It is estimated that if China were to achieve this full implementation, smoking prevalence would decrease from 26.6% in 2018 (*6*) to 20%, and this would lead to the achievement of the Healthy China 2030 goal (*7*).

The theme for the 2021 WHO World No Tobacco Day is "Commit to Quit", which is a year-long campaign launched in December 2020 designed to promote smoking cessation (*8*) — a key component of the FCTC. The FCTC obligates 181 countries, including China, to implement strong tobacco control

* MPOWER: Monitor tobacco use and prevention policies; Protect people from tobacco smoke; Offer help to quit tobacco use; Warn about the dangers of tobacco; Enforce bans on tobacco advertising, promotion and sponsorship; Raise taxes on tobacco.

measures to promote cessation and to prevent tobacco uptake. Article 14 of the FCTC focuses on measures to encourage cessation and treatment for tobacco dependence. Reviews have found that Article 14 implementation has been poor (*9–10*). In 2018, only 23 countries had implemented comprehensive cessation services (*11*), which include implementing effective cessation programs, including diagnosis and treatment of tobacco dependence in health care settings, involving medical and health care professionals, and in taking steps to make evidence-based cessation treatments (e.g., stop smoking medications) available and affordable.

INDICATORS OF CHINA'S PROGRESS IN ARTICLE 14 IMPLEMENTATION

The International Tobacco Control (ITC) Policy Evaluation Project examined indicators of progress on cessation in China in comparison with two other ITC East Asian countries — the Republic of Korea and Japan — based on data from the most recent ITC cohort surveys of smokers [China (2013–2015); Republic of Korea and Japan (2020)]. Extensive information about the methods of the ITC cohort surveys are available elsewhere (*12–15*). Briefly, the ITC China Survey was conducted among 7,817 adult smokers selected using a multistage probability sample in 10 locations in China: 5 cities (Beijing, Shanghai, Guangzhou, Kunming, Shenyang) and 5 rural areas (Changzhi, Huzhou, Tongren, Xining, Yichun). The Republic of Korea web-administered cohort survey was conducted among 3,766 adult smokers from a national survey panel. The Japan web-administered cohort survey was conducted among 2,757 adult smokers from a national survey panel. Table 1 presented the smoking prevalence of the three countries over time.

TABLE 1. Smoking prevalence in China, Japan, and the Republic of Korea over time.

Country	2010	2015	2018
China	28.1%	27.7%	26.6%
Japan	19.5%	18.2%	17.8%*
The Republic of Korea	27.5%	22.6%	22.4%

Note: Smoking prevalences in China are from the 2010 and 2018 Global Adult Tobacco Survey (*6*,*16*) and from the 2015 China Adults Tobacco Survey (*17*). Smoking prevalences in Japan are from the National Health and Nutrition Survey (NHNS) Japan (*18*). Smoking prevalences in the Republic of Korea are from the Republic of Korea National Health and Nutrition Examination Survey (KNHANES) (*19*).

* The smoking prevalence in Japan for 2018 may also include users of heated tobacco products (HTPs), since the NHNS asked about "smoking", thus not making a clear distinction between cigarettes and HTPs.

INTENTIONS TO QUIT AND QUIT ATTEMPTS

ITC cohort surveys asked smokers if they are planning to quit smoking, and if so, their timeframe (next month, next six months, beyond six months). Intentions to quit is a strong predictor of future quit attempts and success. In China, for example, smokers reporting having plans to quit smoking were much more likely than smokers having no plans to quit to report 18 months later that they had attempted to quit (41% *vs.* 17%) (*20*).

Figure 1 presented the percentage of smokers who intended to quit within the next six months at the most recent ITC cohort survey wave in China, Japan, and the Republic of Korea. The majority of Chinese smokers do not have intentions to quit smoking in the near future. However, a higher percentage of smokers in China (28%) and the Republic of Korea (31%) plan to quit in the next six months compared to only 11% of smokers in Japan.

Smokers were also asked about their previous quit attempts. The majority of Chinese smokers reported that they made no attempts to quit smoking in the last year. Approximately 1 in 5 Chinese smokers made attempts to quit (19%), compared to approximately half of smokers in the Republic of Korea (50%) and Japan (54%) (Figure 1).

The gap between intentions to quit and actual quit attempts is striking in China versus its two neighboring countries. Chinese smokers intend to quit at nearly the same proportion (28%) as Korean smokers (31%), both much higher than Japanese smokers (11%). But Chinese smokers are much less likely to actually attempt to quit (19%) compared to Japanese smokers (54%) and Korean smokers (50%). This suggests that Chinese smokers recognize the importance of quitting and want to quit, but these intentions are much less likely to be translated into action. This suggests the importance in China of encouraging and supporting smokers to quit, which is precisely the objective of FCTC Article 14.

PHYSICIAN ADVICE TO QUIT

Physicians and other health professionals are an

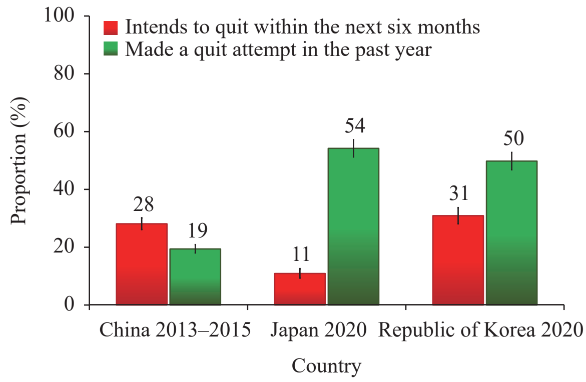

FIGURE 1. Percentage of smokers who intend to quit in the next six months and who made a quit attempt in the past year, by country.

important source of information and motivation for smokers to quit: even very brief advice from physicians can lead to a 1 to 3 percentage point increase in cessation rates (*21*). ITC Surveys asked smokers whether they had visited a physician or other health professional in the last six months and if they received advice to quit smoking during any visit. In China, 56% of smokers who visited a physician or health professional received advice to quit compared to 74% in the Republic of Korea, both significantly higher than 22% of smokers in Japan. In China, there is tremendous room for improvement since 44% of Chinese smokers did NOT receive critically important quit advice from their physician/health professional. This is an even greater need in Japan, where over three-quarters of smokers received no such advice.

SUPPORT FOR STRONGER GOVERNMENT ACTION ON TOBACCO

Figure 2 showed that Chinese smokers were more likely to agree that the government should do more to control smoking (80%), compared to 60% of Korean smokers and 25% of Japanese smokers. Chinese smokers were also much more likely to support a total ban if they received government support to quit (83%) than Korean smokers (42%) and Japanese smokers (29%).

CONCLUSION

These findings demonstrate that smokers in China very much want to quit, and they support stronger action of the government to help them quit, compared

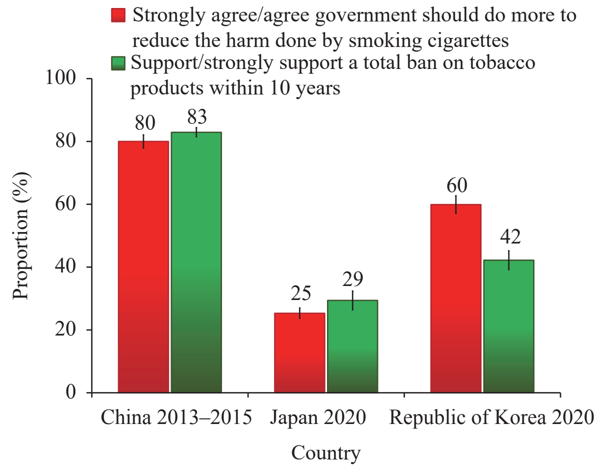

FIGURE 2. Percentage of smokers who support more government action to reduce the harm of cigarettes and who support a total ban on tobacco products within 10 years.

to smokers in the Republic of Korea and Japan. For World No Tobacco Day in 2021, WHO calls on governments to ensure that their citizens have access to brief advice, toll-free quit lines, mobile and digital cessation services, nicotine replacement therapies, and other supports for quitting.

It should be noted, as a limitation, that this study compared data collected in China in 2013–2015 with data collected in 2020 in Japan and the Republic of Korea. Tobacco control efforts at the city level have been reported to improve in China since that time, but that would likely have only increased the level of support among smokers for stronger tobacco control action, thus making any claims that the Chinese people would not support stronger policies even less valid.

China's smoking pandemic has likely not yet peaked in its devastation since the consequences of smoking are experienced in disease and death at a lag of many years (*22*). China has recognized the dire future consequences of smoking and has, in its Healthy China 2030 Plan, committed to reduce its smoking prevalence from 26.6% in 2018 to below 20% in 2030. This study's findings demonstrate that it is important for the Chinese government to strengthen and accelerate actions to achieve this objective and to implement Article 14 as well as other important measures that have been proven to be effective including large pictorial health warnings (Article 11), price and tax increases (Article 6), a comprehensive smoke-free law (Article 8), education campaigns (Article 12) and bans on tobacco advertising and promotion (Article 13).

Despite the clear need for China to implement strong FCTC policies from analyses suggesting that implementing those policies would lead to substantial declines in smoking prevalence (*5*) at levels that would achieve the Healthy China 2030 objective (*7*), and despite the fact that Chinese smokers themselves would support strong implementation, there has been insufficient progress in tobacco control in China. Although there are widespread cultural practices, for example, sharing or gifting cigarettes, that help to sustain and normalize smoking (*23–24*), the tobacco industry's influence is the most important barrier to stronger tobacco control in China (*25*), as it is in Japan (*26*), and globally, especially in low- and middle-income countries (*27*). Once again, China is at the crossroads (*28*).

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Preplanned Studies

Restoration of Population Disability Trajectory During Hundreds of Years — China, 1896–2006

Chao Guo[1,2]; Xiaoying Zheng[1,2,#]

Summary

What is already known about this topic?

A previous study found that the size of population with disability was 52.7 million and 84.6 million in 1987 and 2006, with the weighted disability rate of 4.9% and 6.5%, respectively.

What is added by this report?

This study restored the prevalence of disability and its change trajectory in China during 110 years from 1896 to 2006 across 3 centuries.

What are the implications for public health practice?

This study realized the innovation of cross-sectional data utilization methods and the expansion of the theory of morbidity transformation while making up for the lack of historical data.

With rapid changes of demographic structure and lifestyle, disability should be an important indicator of health evaluation and health promotion. However, due to the limitation of ideas and methods, research on the trend of disability is limited. Using data from the first and second China National Sample Survey on Disability (CNSSD) in 1987 and 2006, we restored the prevalence of population disability and its change trajectory in China during 110 years from 1896 to 2006 across 3 centuries through an innovative application of interdisciplinary methods. We found that since the end of the 19th century, the prevalence of disability among Chinese population presented a trend of fluctuating decreases, decreasing rapidly, and then increasing slowly. Three stages of evolution, which are closely related to the characteristics of social development and changes in mortality, were presented as dividing points in 1949 and 1986. The findings highlight that to further prevent and control disability and improve healthy life expectancy should be the main task and goal of health promotion.

Data used in this study were obtained from the first and second CNSSD in 1987 and 2006. Details about sampling, quality and key conceptions of the surveys can be found in our previous work (*1*–*2*). The two cross-sectional surveys contained the time of disability occurrence which was used as a key parameter to estimate the prevalence of disability in the previous 110 years. Data on total population, natural growth rate of population, mortality, etc., involved in calculations were derived from public information such as statistical yearbooks and literature.

Disability may occur under the combined effect of various risks of disability in the course of an individual's life from birth to death. At the population group level, the disability status of a population is a dynamic process consisting of new disabilities, disability rehabilitation, and death of the persons with disability. Thus, we established a flow chart of the disability process for a population as Figure 1 and considered simultaneous formulas with corresponding parameters to estimate the prevalence of disability in the previous 110 years since 2006 by mirroring reverse receding. The estimation process and details of calculation method were illustrated in Supplementary Figure S1 (available in weekly.chinacdc.cn).

Figure 2 shows the results of the restoration of population disability trajectory during 110 years from 1896–2006 across 3 centuries in China. In 1896, the starting point of this restoration, the prevalence of disability was nearly 55%, and then gradually declined with relatively frequent fluctuations in a certain period. On the whole, since the end of the 19th century, the prevalence of population disability in China presented a trend of decreasing in fluctuation, decreasing rapidly and then increasing slowly.

Further observing the disability trajectory combined with changes of population mortality, we divided the development of population disability in China from 1896 to 2006 into 3 stages, with the dividing points of 1949 and 1986.

Stage I was from 1896 to 1948, i.e., social upheavals and war years, during which the prevalence of disability of China declined from a high level in fluctuations, and the trend was opposite to that of mortality. Since it is difficult to obtain more accurate

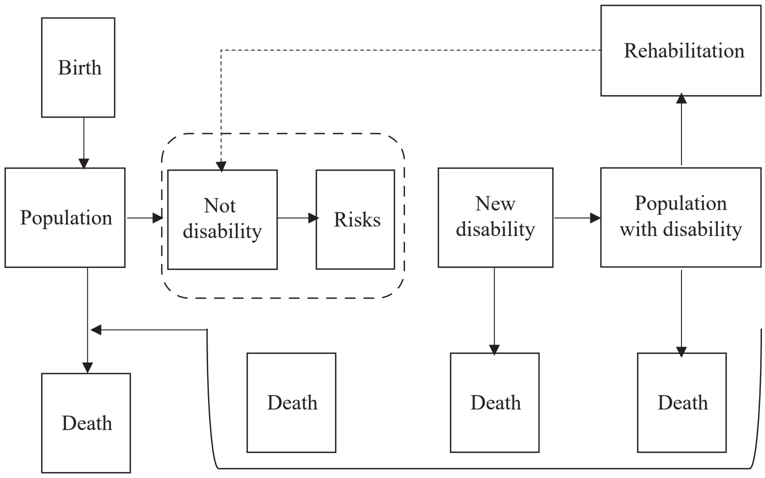

FIGURE 1. Flow chart of the disability process for a population.

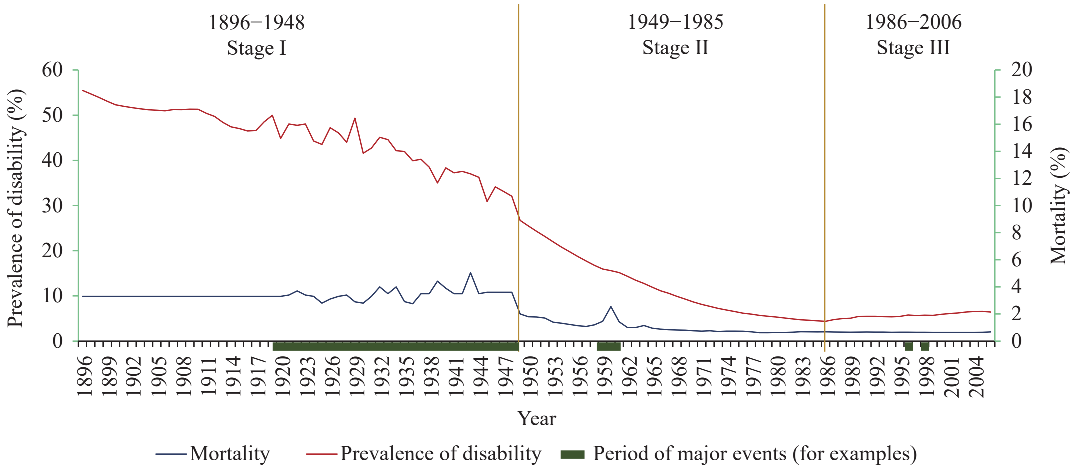

FIGURE 2. Restoration of population disability trajectory in China, 1896–2006.
Note: Major events for examples, a serise of wars during 1919–1948, the great famine during 1959–1961, earthquakes in 1996 and floods in 1998.

information on mortality in the early stages of history, we began to compare disability with mortality in *Stage I* since 1919, when relatively accurate figures of death were available. It is obvious from Figure 2 that during 1919–1948, both disability and mortality showed frequent fluctuations, and the "peaks and valleys" of the two generally fluctuated in the opposite direction.

Stage II was from 1949 to 1985, i.e., the period of founding and early construction of new China, during which the prevalence of disability declined rapidly and showed the same trend as the mortality. And the decline of the prevalence of disability was faster than that of mortality.

Stage III was from 1986 to 2006, i.e., development and deepening of medical reform period, during which the prevalence of disability tended to rise and moved in the opposite direction of mortality. Both the rise of disability and decline of mortality were slow.

DISCUSSION

This study, for the first time, restores the evolutionary trajectory of the prevalence of disability during 110 years spanning 3 centuries from a historical perspective, which provides important information for the change of population health conditions and also contributes to the theory of morbidity transition and the methods of cross-sectional data use.

The 3 stages that we found in the disability trajectory during the 110 years confirmed the partial rationality of the relevant theory of "the compression of morbidity" (*3*) and "the expansion of morbidity" (*4*) with historical data and put forward supplementary ideas to further expand the theory.

Specifically, Fries and Green pointed out that the compression of morbidity is the primary purpose of most health promotion activities in developed societies and there also remain opportunities to lessen mortality in developing societies (*5*). The characteristics of disability and mortality trends in *Stage I* and *Stage II* of our recovery trajectory indicated that the compression of morbidity could be also observed in relatively underdeveloped or developing societies. But its main driver is the low initial health endowment of the population in such societies. In this situation, individual health is vulnerable to risks. Thus, the impacts of risks on disability and death of population, especially on the mortality rate of population with disability, are also high. Therefore, although the prevalence of disability is high, the survival time of population with disability may be short, and the population reproduction or replacement in such societies should be rapid, which corresponds to the *Stage I* of our recovery trajectory. As we all know, China's social environment during this period was volatile and war-prone. The population were living with high mortality and low life expectancy at that time, with about 33 years in the Qing Dynasty and about 35 years in the Republican period (*6*). On the other hand, it could also cause the individual's life to change directly from a state of health to death without the appearance of an intermediate disability state when events such as wars break out, resulting in a "disability-death substitution effect," which led to the opposite fluctuations of the two at this stage.

At the same time, however, the population in a developing society may be also sensitive to protective factors, and marginal health promotion may have a significant effect on the suppression of disability. However, due to the limited progress of medical technology, the rescue of death, especially the death of the persons with disability may not be improved at the same level, so the overall survival time of the population with disabilities is still short, forming a compensatory morbidity compression that most of the survival time is in a healthy state, which corresponds to *Stage II* of our recovery trajectory. This provides evidence to extend the theory of "the compression of morbidity" from the perspective of Chinese population health development.

The characteristics of *Stage III* in our recovery trajectory support the theory of "the expansion of morbidity." That is, when the technological progress of life saving exceeds the technological progress of health promoting, the proportion of living with disability in the total life span will increase (*4*). Moreover, the trends of disability and mortality changes is consistent with Wilson's hypothesis that the prevalence of disability will rise if the reduction of mortality is largely due to the rescue of death by medical technology (*7*). The social and medical development background at this stage in China also supports these theories. As we know, medical reform was conducted officially in China in 1985. With various reform measures, the pharmaceutical market, medical institutions, and research as well as medical workers have been activated rapidly, and the level of medical technology to save life have been rapidly improved.

Furthermore, the interaction between major natural and social events and population health inferred from theory also provides some support for the accuracy of our recovery trajectory. We highlighted some major events in Figure 2. As mentioned above, the frequent fluctuations of disability in *Stage I* coincide with the frequency of wars during 1919–1948. And we can observe an obvious "stagnation" in the rapid decline of the disability trajectory in *Stage II* during 1959–1961, when a great famine was affecting China, in line with the assumption of increasing disability. There were many earthquakes in China in 1996, especially earthquakes in Lijiang and Kunlun mountain with magnitude 7 or above; great floods attacked the Yangtze River, Nenjiang, and Songhua River in 1998. These natural disasters could partially explain the small peaks of disability in that two years shown in *Stage III*. Further studies on the relationship between major social and environmental events and population health under the framework of the events demography are also worthy of exploration through the details reflected by our recovery trajectory.

Unlike previous studies on forward predictions, this study obtains the results in historical periods by "reverse predictions". This is of more valuable academic importance since it is impossible to know a certain indicator in the past historical time if there is no record at that time. The reverse prediction of this study makes up for the lack of disability-related data in historical documents and also provides a scientific data platform for the precise prevention and control of disability. Especially, under the current situation of disability increase with mortality decrease, to further prevent and control disability and improve health life expectancy should be the main task and goal of health promotion. Additionally, by using the index "the time of disability occurrence" innovatively, this study deduced a long-term evolution trajectory from only two national cross-sectional surveys, which realizes the link and utilization of forgotten data, greatly improves the efficiency of data utilization and information acquisition, and provides a feasible technical method for the utilization of similar data.

This study was subject to several limitations. First, this study, to the best of our knowledge, is the first to explore the “reverse prediction,” so the resources for reference in methods and comparison in results are both very limited and the findings need be further studied in the future. Second, we did not decompose the contribution of different types and causes of disability to the trend of disability changes. And the objective of our study is to demonstrate the development of disability, so we did not calculate the age-standardized prevalence to explore the demographic causes of this change. Moreover, since the first CNSSD was conducted in 1987, the development of screening and diagnosis could also contribute to the increase of disability in *Stage III*.

In conclusion, this study recovered the trajectory of disability change in population from 1896 to 2006 with only two national representative cross-sectional surveys. The findings of the transition law of Chinese population disability from the historical perspective emphasize a need for healthcare policy review to better serve population with disability in China, which may be applicable to other similar settings facing population health promotion against a background of population ageing and disability burden.

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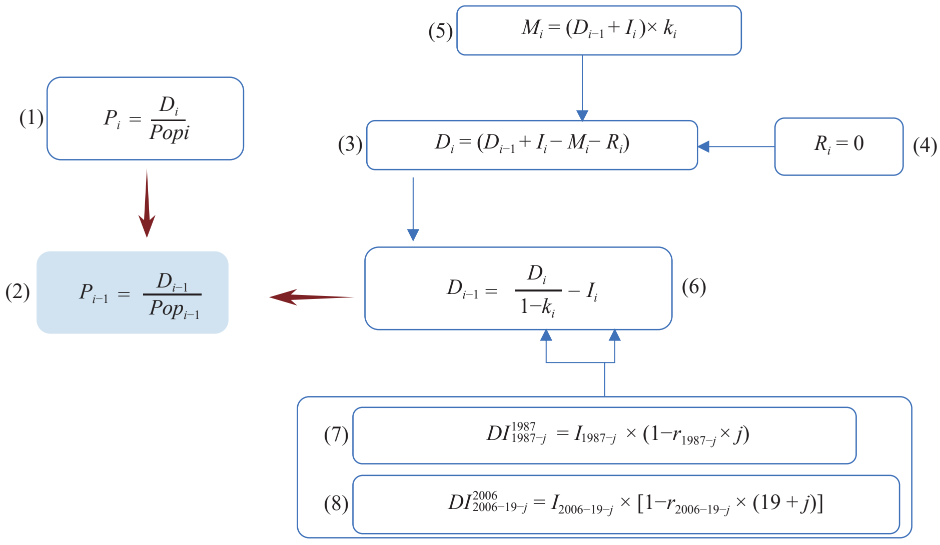
Supplementary File



SUPPLEMENTARY FIGURE S1. The estimation process of the prevalence of disability.

Note: (1) P_i denotes the prevalence of disability in year i, which is equal to the ratio of the size of persons with disability in year i (D_i) to the total population in year i (Pop_i). Pop_i can be obtained from statistical yearbooks and literature.

(2). P_{i-1} denotes the prevalence of disability in year $i-1$.

(3) D_i is formed on the basis of persons with disability in the last year $i-1$ (D_{i-1}), by accumulating new persons with disabilities developed in year i (I_i) and decaying deaths and rehabilitation of the persons with disabilities in that year.

(4) R_i denotes persons with disabilities who recovered in year i. Since very few disabilities can be fully healed through rehabilitation and may only change the degree but not the identification of disability, we assume that R_i is equal to 0.

(5) M_i denotes persons with disabilities who were dead in year i, including both those dead in D_{i-1} and those in I_i; k_i denotes the death rate of persons with disabilities.

(6) D_{i-1} can be obtained by replacing the above parameters.

(7) & (8). In China National Sample Survey on Disability China National Sample Survey on Disability 1987 and 2006, we can obtain I_{1987} and I_{2006}. However, due to the presence of deaths of persons with disabilities, persons with disabilities who died before 1987 and 2006 were unable to report their time of disability occurrence during the survey window. Thus, the number of persons with disabilities reported in survey 1987 and 2006 occurred in years other than the year surveyed is not actually I_i, but is reduced by a certain rate of death r from that year to 1987 or 2006.

DI_i^{1987} and DI_i^{2006} denote persons with disabilities reported in survey 1987 and 2006 occurred in year i, and persons with disabilities occurred in year 1913–2006 were both reported in survey 1987 and 2006. Then, r and I during 1913–1987 can be calculated from equations (7) and (8). We assumed that k during 1913–1987 was linearly altered from r_{1913} to r_{1987}, and k and r during 1890–1912 and during 1988–2005 were equal to r_{1913} and r_{1987}, respectively. Then D_i from 2006 to the year before can then be obtained.

Preplanned Studies

Burden of Skin Disease — China, 1990–2019

Dan Peng[1]; Jinfang Sun[1,#]; Jinyi Wang[1]; Xiao Qi[1]; Guoxing Li[2]

Summary

What is already known about this topic?

Skin diseases are common, affect society and individuals, and have high incidences to relapse, which reduces the quality of life. In 2019, skin diseases were the seventh leading global causes of years lived with disability (YLDs).

What is added by this report?

All-age disability-adjusted life years (DALYs) and YLDs from skin diseases have been steadily increasing in China from 1990 through 2019, although with a decline in the standardized rate of years of life lost (YLLs). In 2019, dermatitis was the leading cause of YLLs among people over the age of 15 years, while viral skin diseases had the greatest burden among people under 15 years. Acne vulgaris increased significantly among people aged 15–49 years, and psoriasis increased among people over 50 years. The male:female ratio of DALYs lost due to skin disease did not change between 1990 and 2019.

What are the implications for public health practice?

The lack of data on the total skin disease burden in China called for additional research. The Global Burden of Disease provided a reference for skin disease control and prevention in China.

To date, there has been no national-level epidemiological survey of skin diseases and their burden in China. Using data from the 2019 Global Burden of Disease (GBD 2019) and China's 2010 national census as the standard population, this study estimated age-standardized incidence, prevalence, mortality, and burden of skin disease in 1990 and 2019. In 2019, there were an estimated 5,393 deaths, 369,127,390 cases of skin diseases, 8,264,702 person-years of disability adjusted life years (DALYs) lost, 8,167,678 person-years of years living with disability (YLDs), and 97,024 person-years of years of life lost (YLLs) caused by skin diseases. In 2019, the age group of 15–49 years had the most number of cases of skin disease, DALYs and YLDs, whereas people over 70 years had the highest incidence, prevalence, and mortality for skin disease. DALYs steadily increased between 1990 and 2019, while DALYs rate declined. The ranking of DALYs by skin disease varied by age group, indicating that the specific disease burdens varied by age.

The GBD provided estimates of incidence, prevalence, mortality, YLLs, YLDs, and DALYs lost due to 369 diseases or injuries in 204 countries and territories (*1*). GBD divided skin and subcutaneous tissue diseases into 12 categories: 1) dermatitis; 2) psoriasis; 3) scabies; 4) fungal skin diseases; 5) viral skin diseases; 6) acne vulgaris; 7) alopecia areata; 8) pruritus; 9) urticaria; 10) decubitus ulcers; 11) bacterial skin diseases; and 12) other skin and subcutaneous diseases (*1–2*). In China, skin disease data were obtained from epidemiological surveillance, disease registries, scientific literature, and other surveys such as the China National Health Services Survey 2008. Information from Chinese data sources can be found online at the Global Health Data Exchange website (*3*).

Specific mortality data were available for 6 skin and subcutaneous diseases using the Cause of Death Ensemble model (CODEm) and spatiotemporal Gaussian process regression, aimed to predict best age-specific and sex-specific mortality estimates by etiology, while considering temporal and spatial trends with the use of predictive covariates, age of death and age-specific standard life expectancy data were used to determine YLLs (*1–2*). A Bayesian meta-regression modelling tool, DisMod-MR 2.1, was used to calculate the prevalence of each skin disease using historical data on incidence, prevalence, remission, mortality, and disease duration. Prevalence estimates were multiplied by disability weights to calculate YLDs by specific cause (*4*). From GBD, sex-specific indicators of incidence, prevalence, mortality, and burden of skin diseases were obtained for 1990 and 2019 and were expressed in numbers (cases) and rates (per 100,000 population). Age-standardized rates of these indicators were calculated using the 2010 population in the national census as the standard population. Percent change (%) was calculated by dividing the difference between 2019 and 1990 values by the 1990 value and multiplying by one hundred. Statistical analyses were performed with SAS (version 9.4, SAS Research Institute, Inc., Cary, USA).

Table 1 shows that standardized skin disease DALYs and YLDs were stable in China between 1990 and 2019, while YLLs rate decreased significantly. DALYs rate and YLDs rate of females were slightly higher than that of males.

Supplementary Table S1 (available in weekly.chinacdc.cn) shows that in 2019, DALYs and YLDs due to skin disease were highest among people aged 15–49 years, while rates of DALYs and YLDs were highest in the 5–14 age group. People over 70 years ranked first among all age groups on YLLs and YLLs rate. Compared with 1990, DALYs and YLDs increased in age groups over 15 years. However, YLLs due to skin disease decreased in all age groups except for the people aged over 70 by years old 2019, and DALYs rate decreased in all age groups except for the 5–14 age group.

In Figure 1, it showed that there was an increase for DALYs and YLDs of skin disease in China from 1990 to 2019, while the rates of DALYs and YLDs decreased slowly. Compared with males, females had higher numbers of DALYs and YLDs, and higher rates of DALYs and YLDs of skin disease.

Supplementary Table S2 (available in weekly.chinacdc.cn) indicated that for DALYs and rate of DALYs, viral skin diseases was the largest contributor among people under 15 years compared with other age groups. Dermatitis contributed the highest number of DALYs and the highest DALY rate among people over 15 years old. As for the ranking of the skin disease burden, acne vulgaris increased significantly in people aged 5–14 years, while in the groups aged over 50 years or above, fungal skin disease and scabies showed a rapid increase.

DISCUSSION

This study used data from the GBD to estimate trends of the burden of skin diseases in China between 1990 and 2019 by age group and sex. These estimates can serve as reference data for China's population that are otherwise unavailable due to the absence national-level skin disease burden surveys in China.

The incidence of skin disease is high. GBD-based estimates show that were 784,395,261 new cases of skin disease in China in 2019, representing an incidence of 53.78%. The prevalence of skin diseases

TABLE 1. Incidence, prevalence, death, disease burden and changes of skin diseases by sex in China, 1990 and 2019.

Groups	Incidence		Prevalence		Deaths		DALYs		YLLs		YLDs	
	Number of cases	Rate* (1/100,000)	Number of cases	Rate* (1/100,000)	Number of cases	Rate* (1/100,000)	Number of person-years	Rate* (1/100,000)	Number of person-years	Rate* (1/100,000)	Number of person-years	Rate* (1/100,000)
Males												
1990	311,782,134	53,257.99	142,257,295	23,376.97	3,238	0.92	3,455,241	554.89	128,804	23.67	3,326,437	531.22
2019	395,228,276	53,753.19	177,940,599	24,623.91	2,613	0.33	3,910,417	545.94	55,039	6.96	3,855,379	538.97
Increase (%)	26.76	0.93	25.08	5.33	−19.31	−64.31	13.17	−1.61	−57.27	−70.59	15.90	1.46
Females												
1990	294,727,431	53,089.72	147,866,780	25,892.05	3142	0.78	3,747,176	634.60	98,168	18.08	3,649,008	616.52
2019	389,166,985	53,803.06	191,186,791	27,337.99	2,780	0.27	4,354,285	641.26	41,986	4.59	4,312,299	636.67
Increase (%)	32.04	1.34	29.30	5.58	−11.52	−65.86	16.20	1.05	−57.23	−74.60	18.18	3.27
Total												
1990	606,509,566	53,166.61	290,124,075	24,598.30	6,380	0.85	7,202,417	593.54	226,972	20.90	6,975,445	572.64
2019	784,395,261	53,776.32	369,127,390	25,951.95	5,393	0.30	8,264,702	592.08	97,024	5.77	8,167,678	586.31
Increase (%)	29.33	1.15	27.23	5.50	−15.47	−65.03	14.75	−0.25	−57.25	−72.41	17.09	2.39

Abbreviations: DALYs=disability-adjusted life years; YLLs=years of life lost; YLDs=years lived with disability.

*: Standardized rates were calculated using the 2010 national census as the standard population, expressed as 1/100,000. The percentage change (%) was calculated as the difference between 2019 and 1990 divided by the amount in 1990.

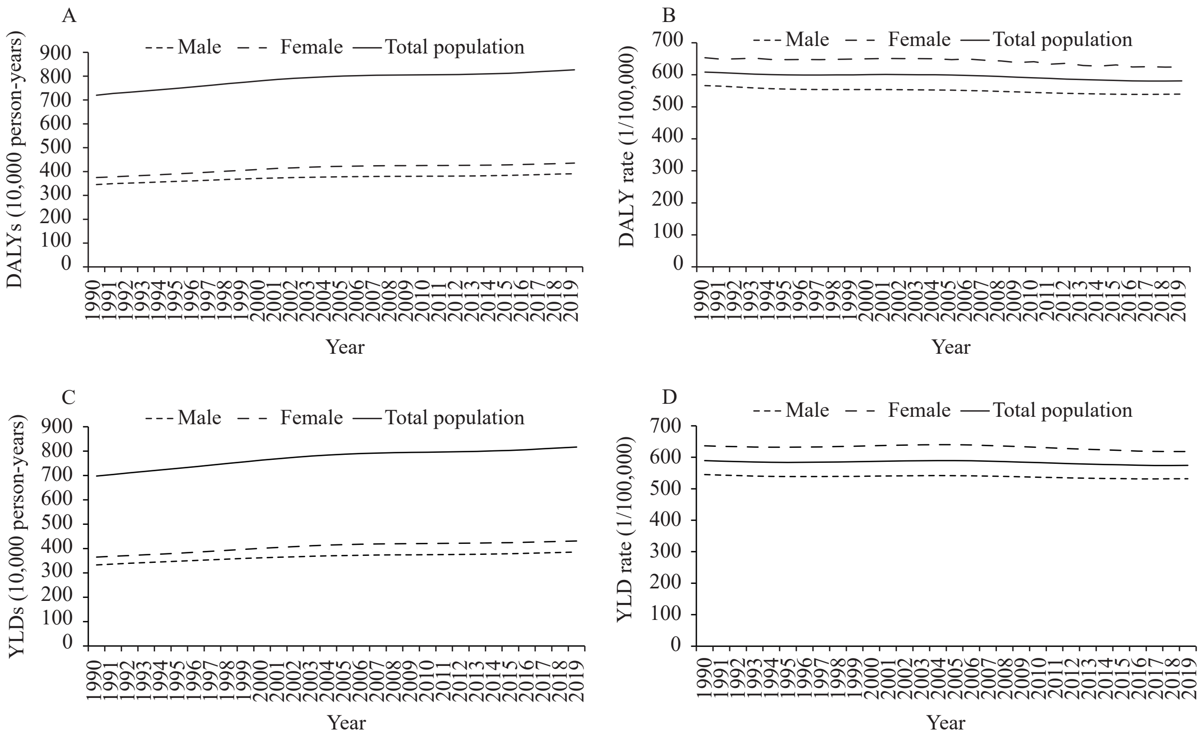


FIGURE 1. DALYs and YLDs by sex for skin disease in China, 1990–2019. (A) DALYs by sex for skin disease in China, 1990–2019; (B) DALY rate by sex for skin disease in China, 1990–2019; (C) YLDs by sex for skin disease in China, 1990–2019; (D) YLD rate by sex for skin disease in China, 1990−2019.
Abbreviations: DALYs=disability-adjusted life years; YLDs=years lived with disability.

was 5.5% higher in 2019 than 1990. Although there have been no national epidemiological studies of skin diseases in China, there have been studies conducted in local areas or for specific skin diseases. For example, in 2008, You Yanming et al. randomly selected 2,345 people in a community in Haidian district of Beijing to conduct a skin diseases survey (*5*), they found that the prevalence of skin disease was 52.22%. Ding Xiaolan et al. conducted an epidemiological survey of psoriasis in 6 cities in China and found that the crude prevalence was 0.59% (*6*). The burden of skin disease is also large and significantly affects quality of life. In 2019, there were 8,264,702 DALYs lost due to skin disease and 97,024 YLLs and 8,167,678 YLDs; 98.83% of DALYs lost from skin disease were YLDs. Compared with 1990, YLLs decreased by 57.25% while YLDs increased by 17.09%. These results can be used to provide guidance on resource allocation and health system responses for skin diseases in China. In 2010, skin conditions were the fourth leading cause of non-fatal conditions, expressed as years lost due to disability. Considering health loss due to premature death, expressed as DALYs, skin diseases are the eighteenth leading cause of disease burden worldwide (*2*). Xu Rongbin et al. found that skin and subcutaneous diseases had the largest number of DALYs lost among Chinese adolescents aged 10–19 years (*7*).

GBD 2019 showed that the disease burden from acne was higher in young and middle-aged groups. Acne is common and affects approximately 9.4% of the global population, making it the eighth most prevalent disease worldwide (*8*). A meta-analysis assessed the prevalence of acne among 83,008 people from 12 provinces in the mainland of China and found that the pooled prevalence of acne was 39.2%. The prevalence of acne among primary and secondary school students (7–17 years old) was 50.2%, and the prevalence among undergraduates (18–23 years old) was 44.5% (*9*).

Psoriasis is also common that an estimated 29.5 million adults across the world suffered from psoriasis in 2017. In China, 2.3 million adults suffer from psoriasis, third in rank by country, after the USA and India (*10*). A systematic review of 76 epidemiological studies of psoriasis from 20 countries found that the estimated prevalence of psoriasis among children was less than 1.37%; among adults, the prevalence ranged from 0.51% to 11.43% (*11*). GBD-based estimates suggest that psoriasis plays a more important role in overall disease burden among people over 50 years of age, and that it is an important disease among middle-aged and elderly people, often requiring intervention.

The study was subject to some limitations. First, GBD analyses is lack of availability of original data. Due to the absence of the original data, the results depend on out-of-sample predictive effectiveness of modeling. Second, misclassification of disease was possible, especially when classifications were deriving from administrative data coded diagnoses (*4*).

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SUPPLEMENTARY TABLE S1. Disease, death and burden of dermatology by age group in China, 1990 and 2019.

Gender	Age group (years)	Year	Incidence		Prevalence		Deaths		DALYs		YLLs		YLDs	
			Number of cases	Rate (1/100,000)	Number of cases	Rate (1/100,000)	Number of cases	Rate (1/100,000)	Number of person-years	Rate (1/100,000)	Number of person-years	Rate (1/100,000)	Number of person-years	Rate (1/100,000)
Males														
	<5													
		1990	32,185,307	52,822.33	12,446,246	20,426.70	595	0.98	352,964	579.28	52,332	85.89	300,632	493.40
		2019	22,821,916	52,018.74	9,343,445	21,296.82	39	0.09	224,187	511.00	3,442	7.84	220,746	503.15
		Increase (%)	−29.09	−1.52	−24.93	4.26	−93.41	−90.84	−36.48	−11.79	−93.42	−90.87	−26.57	1.98
	5–14													
		1990	46,641,768	43,379.00	25,830,822	24,023.86	90	0.08	689,316	641.10	7,118	6.62	682,199	634.48
		2019	33,977,464	43,792.57	19,720,010	25,416.55	12	0.02	516,009	665.07	975	1.26	515,034	663.81
		Increase (%)	−27.15	0.95	−23.66	5.80	−86.26	−80.95	−25.14	3.74	−86.30	−81.02	−24.50	4.62
	15–49													
		1990	172,392,977	49,905.84	79,640,815	23,055.13	591	0.17	1,860,206	538.51	31,983	9.26	1,828,222	529.25
		2019	184,562,889	49,932.36	86,400,134	23,375.03	263	0.07	1,908,765	516.40	13,158	3.56	1,895,608	512.85
		Increase (%)	7.06	0.05	8.49	1.39	−55.56	−58.47	2.61	−4.10	−58.86	−61.55	3.69	−3.10
	50–69													
		1990	45,531,610	57,064.45	18,849,289	23,623.68	689	0.86	439,177	550.42	20,305	25.45	418,872	524.97
		2019	106,742,919	57,856.45	45,210,305	24,504.74	562	0.30	954,303	517.25	16,356	8.87	937,948	508.38
		Increase (%)	134.44	1.39	139.85	3.73	−18.50	−64.75	117.29	−6.03	−19.45	−65.16	123.92	−3.16
	≥70													
		1990	15,030,473	91,050.33	5,490,123	33,257.60	1,273	7.71	113,578	688.02	17,066	103.38	96,512	584.64
		2019	47,123,087	95,701.01	17,266,705	35,066.49	1,737	3.53	307,152	623.79	21,108	42.87	286,044	580.92
		Increase (%)	213.52	5.11	214.50	5.44	36.42	−54.27	170.43	−9.34	23.68	−58.53	196.38	−0.64
Females														
	<5													
		1990	27,366,820	50,249.73	10,081,109	18,510.48	444	0.81	300,942	552.58	38,866	71.36	262,076	481.21
		2019	18,357,407	48,799.05	7,066,653	18,785.11	25	0.07	185,344	492.70	2,210	5.87	183,134	486.82
		Increase (%)	−32.92	−2.89	−29.90	1.48	−94.30	−91.74	−38.41	−10.84	−94.31	−91.77	−30.12	1.17
	5–14													
		1990	44,022,080	44,024.06	25,093,539	25,094.67	62	0.06	694,620	694.65	4,909	4.91	689,711	689.74

TABLE S1. (Continued)

Gender	Age group (years)	Year	Incidence		Prevalence		Deaths		DALYs		YLLs		YLDs	
			Number of cases	Rate (1/100,000)	Number of cases	Rate (1/100,000)	Number of cases	Rate (1/100,000)	Number of person-years	Rate (1/100,000)	Number of person-years	Rate (1/100,000)	Number of person-years	Rate (1/100,000)
		2019	29,675,277	45,167.98	17,752,601	27,020.78	8	0.01	486,051	739.81	666	1.01	485,386	738.79
		Increase (%)	−32.59	2.60	−29.25	7.68	−86.42	−79.33	−30.03	6.50	−86.44	−79.36	−29.62	7.11
	15–49													
		1990	160,120,328	49,569.05	85,476,708	26,461.35	346	0.11	2,171,382	672.20	19,057	5.90	2,152,324	666.30
		2019	175,139,182	49,883.08	93,905,959	26,746.26	112	0.03	2,277,382	648.64	5,654	1.61	2,271,728	647.03
		Increase (%)	9.38	0.63	9.86	1.08	−67.73	−70.31	4.88	−3.50	−70.33	−72.71	5.55	−2.89
	50–69													
		1990	43,031,108	57,944.37	19,434,464	26,169.85	476	0.64	421,056	566.98	13,649	18.38	407,407	548.60
		2019	108,384,018	58,780.94	50,233,993	27,243.88	351	0.19	1,012,801	549.28	9,985	5.42	1,002,817	543.87
		Increase (%)	151.87	1.44	158.48	4.10	−26.16	−70.26	140.54	−3.12	−26.84	−70.54	146.15	−0.86
	≥70													
		1990	20,187,095	92,812.64	7,780,960	35,773.91	1,815	8.34	159,175	731.83	21,687	99.71	137,488	632.12
		2019	57,611,102	98,103.27	22,227,585	37,850.32	2,284	3.89	392,706	668.72	23,472	39.97	369,234	628.75
		Increase (%)	185.39	5.70	185.67	5.80	25.81	−53.40	146.71	−8.62	8.23	−59.91	168.56	−0.53
Total														
	<5													
		1990	59,552,127	51,608.15	22,527,355	19,522.31	1,039	0.90	653,906	566.68	91,199	79.03	562,708	487.65
		2019	41,179,323	50,532.44	16,410,098	20,137.35	65	0.08	409,531	502.55	5,651	6.94	403,880	495.61
		Increase (%)	−30.85	−2.08	−27.15	3.15	−93.79	−91.20	−37.37	−11.32	−93.80	−91.23	−28.23	1.63
	5–14													
		1990	90,663,848	43,689.83	50,924,361	24,539.85	151	0.07	1,383,937	666.90	12,027	5.80	1,371,910	661.11
		2019	63,652,741	44,423.22	37,472,611	26,152.12	21	0.01	1,002,061	699.34	1,641	1.15	1,000,420	698.19
		Increase (%)	−29.79	1.68	−26.42	6.57	−86.32	−80.19	−27.59	4.86	−86.36	−80.24	−27.08	5.61
	15–49													
		1990	332,513,305	49,743.09	165,117,523	24,701.14	936	0.14	4,031,587	603.11	51,041	7.64	3,980,547	595.48
		2019	359,702,071	49,908.36	180,306,093	25,017.32	374	0.05	4,186,147	580.82	18,812	2.61	4,167,336	578.21
		Increase (%)	8.18	0.33	9.20	1.28	−60.05	−62.95	3.83	−3.70	−63.14	−65.82	4.69	−2.90

TABLE S1. (Continued)

Gender	Age group (years)	Year	Incidence		Prevalence		Deaths		DALYs		YLLs		YLDs	
			Number of cases	Rate (1/100,000)	Number of cases	Rate (1/100,000)	Number of cases	Rate (1/100,000)	Number of person-years	Rate (1/100,000)	Number of person-years	Rate (1/100,000)	Number of person-years	Rate (1/100,000)
	50–69													
		1990	88,562,718	57,488.63	38,283,753	24,851.09	1,165	0.76	860,233	558.40	33,954	22.04	826,279	536.36
		2019	215,126,937	58,318.56	95,444,298	25,873.90	913	0.25	1,967,105	533.26	26,341	7.14	1,940,764	526.12
		Increase (%)	142.91	1.44	149.31	4.12	−21.63	−67.27	128.67	−4.50	−22.42	−67.60	134.88	−1.91
	≥70													
		1990	35,217,567	92,052.23	13,271,082	34,688.16	3,088	8.07	272,753	712.93	38,753	101.29	234,001	611.63
		2019	104,734,189	97,007.66	39,494,290	36,580.69	4,020	3.72	699,858	648.23	44,580	41.29	655,278	606.94
		Increase (%)	197.39	5.38	197.60	5.46	30.19	−53.87	156.59	−9.08	15.04	−59.24	180.03	−0.77

Note: Percentage change (%) was calculated as the difference value between 2019 and 1990 divided by the amount in 1990.
Abbreviations: DALYs=disability-adjusted life years; YLLs=years of life lost; YLDs=years lived with disability.

SUPPLEMENTARY TABLE S2. Disease burden by age group and skin disease in China, 1990 and 2019.

Age group (years)	Name of disease	DALYs		DALY rate		YLLs		YLL rate		YLDs		YLD rate	
		1990	2019	1990	2019	1990	2019	1990	2019	1990	2019	1990	2019
<5													
	Viral skin diseases	145,832	105,866	126.38	129.91	–	–	–	–	145,832	105,866	126.38	129.91
	Scabies	145,518	101,351	126.11	124.37	–	–	–	–	145,518	101,351	126.11	124.37
	Dermatitis	123,694	90,382	107.19	110.91	–	–	–	–	123,694	90,382	107.19	110.91
	Urticaria	71,845	51,083	62.26	62.69	–	–	–	–	71,845	51,083	62.26	62.69
	Other skin diseases	41,791	33,286	36.22	40.85	2,373	1,256	2.06	1.54	39,418	32,030	34.16	39.31
5–14													
	Viral skin diseases	342,676	238,625	165.13	166.54	–	–	–	–	342,676	238,625	165.13	166.54
	Acne vulgaris	250,397	232,490	120.66	162.25	–	–	–	–	250,397	232,490	120.66	162.25
	Dermatitis	252,691	174,975	121.77	122.12	–	–	–	–	252,691	174,975	121.77	122.12
	Scabies	258,973	174,780	124.80	121.98	–	–	–	–	258,973	174,780	124.80	121.98
	Urticaria	113,030	77,519	54.47	54.10	–	–	–	–	113,030	77,519	54.47	54.10
15–49													
	Dermatitis	932,108	1,064,399	139.44	147.68	–	–	–	–	932,108	1,064,399	139.44	147.68
	Scabies	841,859	815,752	125.94	113.18	–	–	–	–	841,859	815,752	125.94	113.18
	Acne vulgaris	622,315	640,193	93.10	88.83	–	–	–	–	622,315	640,193	93.10	88.83
	Viral skin diseases	434,253	423,647	64.96	58.78	–	–	–	–	434,253	423,647	64.96	58.78
	Psoriasis	322,404	299,176	48.23	41.51	–	–	–	–	322,404	299,176	48.23	41.51
50–69													
	Dermatitis	263,624	636,608	171.13	172.58	–	–	–	–	263,624	636,608	171.13	172.58
	Scabies	119,613	282,625	77.64	76.62	–	–	–	–	119,613	282,625	77.64	76.62
	Psoriasis	143,758	260,602	93.32	70.65	–	–	–	–	143,758	260,602	93.32	70.65
	Other skin diseases	68,987	193,016	44.78	52.32	1,381	2,459	0.90	0.67	67,606	190,557	43.89	51.66
	Viral skin diseases	76,616	182,333	49.73	49.43	–	–	–	–	76,616	182,333	49.73	49.43
≥70													
	Dermatitis	72,207	202,583	188.74	187.64	–	–	–	–	72,207	202,583	188.74	187.64
	Scabies	31,093	88,233	81.27	81.72	–	–	–	–	31,093	88,233	81.27	81.72
	Fungal skin diseases	28,945	86,131	75.66	79.78	–	–	–	–	28,945	86,131	75.66	79.78
	Psoriasis	34,727	73,871	90.77	68.42	–	–	–	–	34,727	73,871	90.77	68.42
	Other skin diseases	22,861	72,807	59.75	67.44	1,824	3,179	4.77	2.94	21,037	69,628	54.99	64.49

Abbreviations: DALYs=disability-adjusted life years; YLLs=years of life lost; YLDs=years lived with disability.

Preplanned Studies

Incidence and Risk Factors of Hypertensive Disorders of Pregnancy — 8 Provinces, China, 2014–2018

Wei Zhao[1]; Jiangli Di[1,#]; Aiqun Huang[1]; Qi Yang[1]; Huanqing Hu[1]

Summary

What is already known about this topic?

As a major cause of maternal and neonatal mortality and morbidity, hypertensive disorders of pregnancy (HDP) are a global public health problem affecting maternal and children's health.

What is added by this report?

The incidence of HDP was 6.40% among 277,632 pregnant women. With the progress of pregnancy, the proportion of pregnant women with high normal blood pressure (BP) and the incidence of HDP increased gradually. The incidence of HDP increased with pregnancy age, body mass index, and BP of pregnant women during first trimester.

What are the implications for public health practice?

To reduce the incidence of HDP effectively, we should pay more attention to older women who plan to become pregnant, measures should be taken to control BP and weight in pre-pregnancy.

Hypertensive disorders of pregnancy (HDP) are a group of diseases associated with elevated blood pressure (BP). As a major cause of maternal and neonatal mortality and morbidity, HDP can trigger severe forms of maternal complications (*1*) and is a risk factor for hypertension (HTN) and other cardiovascular diseases after pregnancy (*2*), seriously affecting maternal and children's health. In China, most of the relevant literature has been focused on a small sample of individual hospitals or just one disease in HDP (*3*). This study is based on population monitoring data to obtain the BP level in pregnancy, the incidence of HDP in monitoring areas of China, and related influencing factors, so as to provide a scientific basis for the development of HDP control and prevention.

Through the Maternal and Newborn Health Monitoring System* (MNHMS), a total of 277,632 single-fetus pregnant women that delivered during 2014–2018 in 16 counties of 8 provinces were monitored. The incidence of HDP was 6.40%. BP and the incidence of HDP increased with age, body mass index (BMI) and BP during the first trimester, and the gestational age. Primiparity, history of cesarean, lower education level, living in rural areas were the risk factors for HDP. Therefore, more measures should be taken to avoid advanced pregnancy and strengthen pre-pregnancy healthcare, so that pregnant women maintain their BP and weight within the normal range pre-pregnancy, which can reduce the occurrence of HDP effectively.

Data were obtained from the MNHMS set up by the National Center for Women and Children's Health (NCWCH) for Maternal and Newborn Health Monitoring Program† (MNHMP) in 2013. A total of 281,283 women (delivered between January 1, 2014 and December 31,2018) had at least 1 record of BP during prenatal examination. Women with 2 or multiple fetuses (3,388 persons), with only 1 record but abnormal value of BP (263 persons), were excluded. Finally, the data of 277,632 registered pregnant women were analyzed in this study.

The highest value of BP readings in each antenatal examination during each trimester was documented and analyzed. According to "Diagnosis and Treatment of Hypertension and Pre-eclampsia in Pregnancy: A Clinical Practice Guideline in China (2020)" (*4*), "Internal Medicine (Ninth Edition)," and research needs, BP was divided into 5 categories: systolic BP (SBP)<90 and/or diastolic BP (DBP)<60 was low; 90≤

* The MNHMS was established to monitor the antenatal health care and pregnancy outcomes of pregnant women who had lived more than 6 months in the 16 districts/counties of 8 provinces. The 8 provinces (with the selected districts) are: Hebei (Xinhua and Zhengding), Liaoning (Lishan, Tiedong and Tai'an), Fujian (Haicang and Jimei), Hubei (Macheng and Luotian), Hunan (Yueyanglou and Yueyang), Guangdong (Zijin and Longchuan), Sichuan (Gongjing and Rong county), and Yunnan (Tonghai and Huaning). Among them, Macheng and Luotian in Hubei, Zijin and Longchuan in Guangdong, and Tiedong in Liaoning joined the project in 2016, and Tai'an in Liaoning withdrew in 2016.

† To ensure the quality of the information, the system set many logics checks to prevent wrong inputs. In addition, the staff of the NCWCH conducted field supervision on data accuracy every year. MNHMP was approved by the Ethics Committee of the NCWCH (No.FY2015-007).

SBP<120 and/or 60≤DBP<80 was normal; 120≤SBP<140 and/or 80≤DBP<90 was high normal; 140≤SBP<160 and/or 90≤DBP<110 was generally high; and SBP≥160 and/or DBP≥110 was severely high. The standard for HDP was at least 1 measurement of SBP≥140 mmHg and/or DBP≥90 mmHg.

The mean age of pregnant women was 28.0±4.7 years old. The mean number of antenatal examinations was 7.3±3.5 times, and the mean gestational week of delivery was 39.0±1.5 weeks. The mean max SBP during pregnancy was 120.4±11.0 mmHg, and the mean max DBP was 76.5±8.1 mmHg. The total incidence of HDP was 6.40%.

The rate of detection of HDP in first, second, and third trimester of pregnancy was 0.89%, 1.80%, and 5.62%, respectively. From the first trimester to third trimester, non-HDP pregnant women had an average increase of 11.7 mmHg in SBP and 6.8 mmHg in DBP, while HDP pregnant women had an average increase of 20.9 mmHg in SBP and 15.0 mmHg in DBP. The proportion of the low group and the normal group of SBP and DBP decreased, while the proportions of the high normal group, the generally high group, and the severely high group increased gradually. (Table 1)

There were statistically significant differences in the levels of BP and the incidence of HDP between different provinces, ages, education levels, ethnicities, pregnancy histories, antenatal examination times, BMIs, and BPs during initial examination in first trimester and whether with gestational diabetes mellitus (GDM) (P<0.05). The highest age-standardized incidence of HDP was in Yunnan (8.42%), followed by in Hebei (7.99%), Liaoning (7.95), Fujian (6.53%), Hubei (6.27%), Sichuan (5.20%), and Hunan (4.39%), and the lowest was in Guangdong (3.20%). The age-standardized incidence of HDP in ethnic minorities (7.43%) was higher than those with Han ethnicity (6.38%). Pregnant women with lower education, primiparity, history of abortion or cesarean section, and GDM had higher incidence of HDP. With an increase in age, BMI, and BP in the first trimester and the number of antenatal examinations, SBP, DBP, and the incidence of HDP increased (Table 2).

The multivariable logistic regression analysis showed that living in rural areas, older age, lower education, history of cesarean section, GDM, and high BMI in first trimester were risk factors for HDP. Taking 25–29 years old as reference, odds ratio (OR) values of 35–39 years old and over 40 years old were 1.832 and 2.650, respectively. Taking normal weight in first trimester as reference, OR values of overweight and obesity were 2.145 and 4.998, respectively (Table 3).

TABLE 1. BP levels and classification proportion in different trimesters of pregnant women — 8 provinces in China, 2014–2018 (95%CI).

Variables	N	BP (mmHg)			Classification proportion (%)				
		Total	Non HDP	HDP	Low	Normal	High normal	Generally high	Severely high
SBP									
First trimester	167,237	106.7 (106.7–106.8)	106.1 (106.0–106.2)	115.8 (115.6–116.1)	1.47 (1.41–1.53)	82.41 (82.23–82.59)	15.73 (15.56–15.90)	0.35 (0.32–0.38)	0.04 (0.03–0.05)
Second trimester	252,172	112.9 (112.9–113.0)	112.1 (112.1–112.2)	124.6 (124.4–124.8)	0.42 (0.39–0.45)	67.73 (67.55–67.91)	30.91 (30.73–31.09)	0.86 (0.82–0.90)	0.09 (0.08–0.10)
Third trimester	261,106	119.1 (119.0–119.1)	117.8 (117.8–117.8)	136.7 (136.5–136.9)	0.08 (0.07–0.09)	46.48 (46.29–46.67)	50.39 (50.20–50.58)	2.74 (2.68–2.80)	0.32 (0.30–0.34)
P value		<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
DBP									
First trimester	167,209	67.8 (67.8-67.9)	67.4 (67.3-67.4)	75.0 (74.8-75.2)	5.44 (5.33-5.55)	83.18 (83.00-83.36)	10.64 (10.49-10.79)	0.71 (0.67-0.75)	0.03 (0.02-0.04)
Second trimester	252,168	70.7 (70.7–70.7)	70.1 (70.0–70.1)	80.0 (79.8–80.2)	3.77 (3.70–3.84)	77.91 (77.75–78.07)	16.98 (16.83–17.13)	1.30 (1.26–1.34)	0.04 (0.03–0.05)
Third trimester	261,109	75.3 (75.3–75.3)	74.2 (74.2–74.3)	90.0 (89.9–90.1)	1.31 (1.27–1.35)	62.46 (62.27–62.65)	31.81 (31.63–31.99)	4.22 (4.14–4.30)	0.20 (0.18–0.22)
P value		<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*

Note: Related definitions: first trimester is from the beginning of pregnancy to the end of the 12th week, second trimester is from the 13th week of pregnancy to the end of the 27th week, and third trimester is from the 28th week of pregnancy to the end of childbirth.

Classification of SBP: SBP<90 is low, 90≤SBP<120 is normal, 120≤SBP<140 is high normal, 140≤SBP<160 is generally high, SBP≥160 is severely high.

Classification of DBP: DBP<60 is low, 60≤DBP<80 is normal, 80≤DBP<90 is high normal, 90≤DBP<110 is generally high, DBP≥110 is severely high.

Abbreviations: BP=blood pressure, SBP=systolic blood pressure, DBP=diastolic blood pressure,

* the P value of linear trend test.

TABLE 2. BP levels and incidence of HDP among different factors of pregnant womenin 8 provinces in China, 2014–2018 (95%CI).

Variables	N	SBP (mmHg)	DBP (mmHg)	Incidence of HDP (%)	
				Roughness	Age-standardized
Province					
Hebei	61,270	120.0(119.9–120.0)	76.8(76.8–76.9)	7.95(7.74–8.16)	7.99(7.78–8.20)
Liaoning	18,482	119.0(118.9–119.2)	77.1(77.0–77.2)	8.32(7.92–8.72)	7.95(7.56–8.34)
Fujian	56,672	124.4(124.3–124.5)	76.3(76.2–76.3)	6.53(6.33–6.73)	6.53(6.32–6.74)
Hubei	32,058	115.6(115.4–115.7)	75.1(75.0–75.2)	6.17(5.91–6.43)	6.27(6.00–6.54)
Hunan	40,122	120.1(120.0–120.2)	75.9(75.8–75.9)	4.47(4.27–4.67)	4.39(4.19–4.59)
Guangdong	21,771	121.2(121.0–121.3)	74.6(74.5–74.7)	3.27(3.03–3.51)	3.20(2.97–3.43)
Sichuan	21,835	119.2(119.0–119.3)	76.9(76.8–77.0)	5.13(4.84–5.42)	5.20(4.90–5.50)
Yunnan	25,422	120.5(120.3–120.6)	79.7(79.6–79.8)	8.05(7.72–8.38)	8.42(8.08–8.76)
P value		<0.001	<0.001		<0.001
Area type					
Urban	136,832	121.5(121.5–121.6)	76.4(76.3–76.4)	6.52(6.39–6.65)	6.42(6.29–6.55)
Rural	140,800	119.3(119.2–119.3)	76.6(76.5–76.6)	6.28(6.15–6.41)	6.38(6.25–6.51)
P value		<0.001	<0.001		0.675
Age of pregnancy (y)					
≤19	5,598	118.7(118.4–119.0)	75.6(75.4–75.8)	4.50(3.96–5.04)	–
20–24	56,228	119.8(119.7–119.9)	76.3(76.2–76.3)	5.45(5.26–5.64)	–
25–29	124,225	120.1(120.0–120.1)	76.3(76.3–76.4)	5.87(5.74–6.00)	–
30–34	63,191	120.9(120.8–121.0)	76.6(76.6–76.7)	6.93(6.73–7.13)	–
35–39	22,649	122.0(121.8–122.1)	77.3(77.2–77.4)	9.29(8.91–9.67)	–
≥40	4,417	123.8(123.4–124.2)	78.5(78.3–78.8)	13.06(12.07–14.05)	–
P value		<0.001*	<0.001*	<0.001*	–
Education level					
Junior high school or lower	94,482	120.5(120.4–120.5)	76.8(76.7–76.8)	6.83(6.67–6.99)	6.83(6.67–6.99)
Senior high	79,642	119.7(119.6–119.7)	76.4(76.3–76.4)	6.20(6.03–6.37)	6.30(6.13–6.47)
University or above	89,357	121.1(121.0–121.2)	76.4(76.3–76.4)	6.05(5.89–6.21)	5.96(5.80–6.12)
P value		<0.001	<0.001		<0.001*
Ethnicity					
Han	260,306	120.3(120.3–120.4)	76.5(76.4–76.5)	6.39(6.30–6.48)	6.38(6.29–6.47)
Others	8,011	119.7(119.5–119.9)	78.2(78.0–78.3)	7.05(6.49–7.61)	7.43(6.85–8.01)
P value		<0.001	<0.001		<0.001
Parity					
0	148,878	120.1(120.0–120.1)	76.6(76.6–76.7)	6.60(6.47–6.73)	7.05(6.92–7.18)
≥1	120,059	120.9(120.9–121.0)	76.4(76.4–76.4)	6.37(6.23–6.51)	5.81(5.68–5.94)
P value		<0.001	<0.001		<0.001
History of cesarean section					
No	223,153	120.3(120.3–120.3)	76.4(76.4–76.5)	6.27(6.17–6.37)	6.37(6.27–6.47)
Yes	45,787	121.2(121.1–121.3)	76.9(76.9–77.0)	7.57(7.33–7.81)	6.96(6.73–7.19)
P value		<0.001	<0.001		<0.001

TABLE 2. (Continued)

Variables	N	SBP (mmHg)	DBP (mmHg)	Incidence of HDP (%)	
				Roughness	Age-standardized
History of abortion					
No	136,853	121.0(120.9–121.0)	76.7(76.7–76.7)	6.36(6.23–6.49)	6.53(6.40–6.66)
Yes	79,257	120.8(120.7–120.9)	77.0(77.0–77.1)	7.12(6.94–7.30)	6.75(6.57–6.93)
P value		<0.001	<0.001		0.049
GDM					
No	128,533	121.3(121.3–121.4)	76.6(76.5–76.6)	6.29(6.16–6.42)	6.18(6.05–6.31)
Yes	6,930	126.1(125.9–126.4)	78.4(78.2–78.6)	10.29(9.57–11.01)	9.73(9.03–10.43)
Unchecked	142,169	119.3(119.2–119.3)	76.3(76.3–76.4)	6.30(6.17–6.43)	6.46(6.33–6.59)
P value		<0.001	<0.001		<0.001
BMI in first trimester (kg/m^2)					
Lean	25,772	118.4(118.3–118.6)	75.3(75.2–75.4)	3.29(3.07–3.51)	3.36(3.14–3.58)
Normal	108,384	120.1(120.1–120.2)	76.3(76.3–76.4)	4.87(4.74–5.00)	4.87(4.74–5.00)
Overweight	24,151	124.0(123.8–124.1)	79.4(79.3–79.5)	10.89(10.50–11.28)	10.61(10.22–11.00)
Obesity	7,096	127.8(127.5–128.0)	82.9(82.7–83.1)	22.82(21.84–23.80)	22.45(21.48–23.42)
Unchecked	112,229	119.9(119.8–119.9)	75.9(75.8–75.9)	6.57(6.43–6.71)	6.57(6.42–6.72)
P value		<0.001*	<0.001*		<0.001*
BP in first trimester					
Low	11,056	116.8(116.6–117.0)	72.0(71.8–72.1)	2.17(1.90–2.44)	2.17(1.90–2.44)
Normal	124,036	119.2(119.2–119.3)	76.0(75.9–76.0)	4.10(3.99–4.21)	4.12(4.01–4.23)
High normal	29,850	127.6(127.5–127.7)	81.8(81.8–81.9)	12.77(12.39–13.15)	12.58(12.20–12.96)
High	1,308	141.3(140.5–142.1)	94.9(94.4–95.4)	100	100
Unchecked	111,382	119.9(119.8–120.0)	75.9(75.8–75.9)	6.56(6.41–6.71)	6.55(6.40–6.70)
P value		<0.001*	<0.001*		<0.001*
Number of antenatal examinations					
1–3	36,067	114.0(113.9–114.1)	71.7(71.6–71.7)	3.30(3.12–3.48)	3.27(3.09–3.45)
4–6	91,579	118.8(118.8–118.9)	75.8(75.7–75.8)	5.12(4.98–5.26)	5.12(4.98–5.26)
7–9	73,980	122.0(121.9–122.0)	77.5(77.5–77.6)	7.60(7.41–7.79)	7.54(7.35–7.73)
≥10	76,006	123.8(123.7–123.9)	78.7(78.6–78.7)	8.23(8.03–8.43)	8.30(8.10–8.50)
P value		<0.001*	<0.001*		<0.001*

Note: first trimester is from the beginning of pregnancy to the end of the 12th week; "-" means the variable needn't to be age-standardized. Classification of BMI: 18.5≤BMI<24 kg/m^2 is normal, BMI<18.5 kg/m^2 is lean, 24≤BMI<28 kg/m^2 is overweight, BMI≥28 kg/m^2 is obesity.
Abbreviations: BP=blood pressure, HDP=hypertensive disorders of pregnancy, SBP=systolic blood pressure, DBP=diastolic blood pressure, GDM=gestational diabetes mellitus, BMI=body mass index.
* the *P* value of linear trend test.

TABLE 3. Multivariate logistic regression model for HDP — 8 provinces in China, 2014–2018.

Variables	*β*	S.E.	Wald χ^2	*P* value	OR	95%CI
Province						
Hunan					Ref	
Hebei	0.356	0.035	105.215	<0.001	1.428	1.334–1.528
Liaoning	0.181	0.043	17.820	<0.001	1.198	1.102–1.303
Fujian	0.153	0.039	15.633	<0.001	1.166	1.080–1.257
Hubei	0.271	0.042	41.107	<0.001	1.311	1.207–1.424
Guangdong	–0.405	0.051	64.011	<0.001	0.667	0.604–0.737

TABLE 3. (Continued)

Variables	*β*	S.E.	Wald χ^2	*P* value	OR	95%CI
Sichuan	–0.224	0.044	25.727	<0.001	0.799	0.733–0.872
Yunnan	–0.002	0.041	0.003	0.953	0.998	0.920–1.082
Areas						
Urban					Ref	
Rural	0.220	0.023	88.876	<0.001	1.246	1.190–1.304
Age of pregnancy (y)						
≤19	–0.392	0.071	30.714	<0.001	0.676	0.588–0.776
20–24	–0.136	0.024	31.356	<0.001	0.873	0.833–0.916
25–29					Ref	
30–34	0.226	0.022	110.058	<0.001	1.253	1.202–1.307
35–39	0.606	0.028	455.792	<0.001	1.832	1.733–1.937
≥40	0.975	0.050	373.888	<0.001	2.650	2.401–2.925
Education						
Junior high school or lower	0.135	0.021	41.739	<0.001	1.144	1.098–1.192
Senior high					Ref	
University or above	–0.237	0.023	109.753	<0.001	0.789	0.755–0.825
Parity						
0					Ref	
≥1	–0.432	0.023	350.459	<0.001	0.649	0.620–0.679
History of cesarean section						
No					Ref	
Yes	0.130	0.025	26.108	<0.001	1.139	1.083–1.197
GDM						
No					Ref	
Yes	0.307	0.044	48.353	<0.001	1.359	1.247–1.482
Unchecked	–0.026	0.018	2.006	0.157	0.974	0.939–1.010
BMI in first trimester (kg/m^2)						
Lean	–0.365	0.039	85.992	<0.001	0.694	0.643–0.750
Normal					Ref	
Overweight	0.763	0.026	838.535	<0.001	2.145	2.037–2.258
Obesity	1.609	0.034	2285.146	<0.001	4.998	4.679–5.339
Unchecked	0.451	0.021	459.159	<0.001	1.571	1.507–1.637
Number of antenatal examinations						
1–3	–0.569	0.035	261.247	<0.001	0.566	0.528–0.606
4–6					Ref	
7–9	0.382	0.023	278.406	<0.001	1.465	1.401–1.533
≥10	0.621	0.026	589.2	<0.001	1.861	1.770–1.957

Note: first trimester is from the beginning of pregnancy to the end of the 12th week.
Classification of BMI: 18.5≤BMI<24 kg/m^2 is normal, BMI<18.5 kg/m^2 is lean, 24≤BMI<28 kg/m^2 is overweight, BMI≥28 kg/m^2 is obesity.
Abbreviations: BP=blood pressure, HDP=hypertensive disorders of pregnancy, GDM=gestational diabetes mellitus, BMI=body mass index, *β*=regression coefficient, S.E.=standard error, OR=odds ratio, CI=confidence interval.

DISCUSSION

The increase of BP in normal ranges during pregnancy may be an adaptive physiological response. However, excess increase in BP would lead to HDP and endanger maternal and infant health. This study showed that with the progress of pregnancy, SBP and DBP increased gradually in HDP pregnant women or non-HDP pregnant women, and the proportion of pregnant women with high normal BP and the incidence of HDP were also increased, which is consistent with a previous study (*5*). However, some studies believed that BP was lowest in the second trimester, then rose in the third trimester (*6*–*7*). A study by Wang et al. (*8*) showed that the SBP/DBP of 18–24 and 25–34-year-old was 117.4/71.4 mmHg and 118.9/73.2 mmHg, respectively, and the corresponding prevalence of HTN was 4.0% and 6.1%, respectively. In this study, the SBP/DBP of pregnant women under 24 years old and 25–34 years old was 119.7/76.2 mmHg and 120.3/76.4 mmHg, respectively, and the incidence of HDP was 5.45% and 6.23%, respectively, which were higher than the BP level and the prevalence of HTN in the total women population of the same age group in the above study. Therefore, we should pay more attention to control BP when women become pregnant.

Many studies have shown that the incidence of HDP in different countries was 5%–10% (*1*,*9*–*10*). The incidence of HDP was 6.40% in this study. This is consistent with a cross-sectional survey conducted by Ye et al. in 2011 based on about 110,000 Chinese people, in which the prevalence of HDP in China was 5.22% (*3*). In this study, the age-standardized incidence of HDP was highest in Yunnan, followed by Hebei, Liaoning, Fujian, Hubei, and Sichuan, and lowest in Hunan and Guangdong, part of which were consistent with the Ye et al. study on HDP (*3*) and the Wang et al. study on HTN (*8*). This indicated that regional differences were important factors affecting HDP.

This study concluded that the incidence of HDP increased with age, BP, and BMI in the first trimester. The age-standardized incidence of HDP with high normal BP in the first trimester (12.58%) was about 3 times higher than that with normal BP (4.12%). Compared with pregnant women aged 25–29 years old, the risk of HDP was nearly doubled over 35 years old (OR=1.832) and increased up to 2.7 times over 40 years old (OR=2.650). Taking pregnant women with normal weight in first trimester as reference, pregnant women with overweight had a doubled risk for HDP (OR=2.145) and with obesity increased the risk up to 5 times (OR=4.998), which were similar to the results of several related studies (*3*,*8*,*10*). Another important finding of this study was that, although the incidence of HDP in urban areas had no difference with that in rural areas, rural areas became a risk factor in multivariable analysis. Lower education was a risk factor for HDP, which was similar to some of the results of related studies (*3*,*8*). This may be related to pregnant women living in rural areas or with lower education having lower levels of pregnancy health knowledge and more unhealthy behavior.

In conclusion, although BP during pregnancy increases are expected, important risk factors for the occurrence of HDP include area types (rural or urban residence), maternal age, early pregnancy weight, and BP. Therefore, we should pay more attention to high-risk groups, especially to older women who plan to become pregnant, and strengthen pre-pregnancy healthcare so that more pregnant women can maintain their BP and weight within normal ranges before pregnancy, thereby reducing the occurrence of HDP effectively.

One of the strengths of this study is using the BP data from individual clinical data of pregnant women in all midwifery institutions in the monitoring areas during 2014–2018, thereby reducing the time bias and institution selection bias. However, this study was subject to some limitations. First, the monitoring area was limited to 16 counties/districts in 8 provinces, so the results might not be representative of the regional and national levels. Second, due to the limited data, BP and weight before pregnancy, history of HTN, smoking and drinking, family history, and other pregnancy complications with a high rate of being missing from the data were not included as influencing factors, so it was impossible to further analyze the incidence of each group of HDP diseases.

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