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Emergence of chronic non-communicable diseases in China

Gonghuan Yang, Lingzhi Kong, Wenhua Zhao, Xia Wan, Yi Zhai, Lincoln C Chen, Jeffrey P Koplan

China has experienced an epidemiological transition shifting from the infectious to the chronic diseases in much shorter time than many other countries. The pace and spread of behavioural changes, including changing diets, decreased physical activity, high rates of male smoking, and other high risk behaviours, has accelerated to an unprecedented degree. As a result, the burden of chronic diseases, preventable morbidity and mortality, and associated health-care costs could now increase substantially. China already has 177 million adults with hypertension; furthermore, 303 million adults smoke, which is a third of the world’s total number of smokers, and 530 million people in China are passively exposed to second-hand smoke. The prevalence of overweight people and obesity is increasing in Chinese adults and children, because of dietary changes and reduced physical activity. Emergence of chronic diseases presents special challenges for China’s ongoing reform of health care, given the large numbers who require curative treatment and the narrow window of opportunity for timely prevention of disease.

Introduction

Many profound changes began with the formation in 1950 of the People’s Republic of China, and one of the most striking was a rapid improvement in disease prevention and control leading to marked increases in longevity.1 The epidemiological transition, which occurred earlier and at a slower pace in many western nations was compressed into only a few decades in China, as the predominant cause of mortality shifted from the infectious diseases and perinatal conditions to chronic diseases and injuries. This shift in the contributing causes of mortality was achieved through health interventions such as increased vaccination coverage; better hygiene, sanitation and water quality; improved access to medical care; and advanced social and living standards such as universal education, higher incomes, and better nutrition and housing. Population age structure is also shifting due to fertility and mortality decline, thereby increasing the proportion of elderly people.2

In more recent decades, the momentum of China’s epidemiological transition has continued unabated. Many of the known risk factors for chronic diseases have dramatically increased as societal change progresses. These behavioural elements include changing diets, levels of physical activity, tobacco consumption, and automobile use. These same behavioural shifts have been observed in many developed countries over the past 50 years, but they have accelerated at a historically unprecedented pace and scale in China, accompanying the rapid growth of the national economy over the past 30 years.

We will describe the changing patterns of mortality in China, focusing on recent data on prevalence of key behavioural risk factors. The likely effect of these behavioural changes on the health of Chinese people will exacerbate the enormous challenges that chronic diseases will present to efforts to reform the nation’s health-care system.

Definitions and data

We used national censuses in 1982,1 1990,7 and 20008 to obtain population and mortality data from all households. The 1982 census (with a reference date of July 1, 1982) collected information on all deaths in the calendar year 1981; the 1990 census (with a reference date of July 1, 1990) collected death information in the calendar year 1989 and between January and June, 1990; the 2000 census (with a reference date of Nov 1, 2000) collected death information in the 12 months before the census, between November, 1999, and October, 2000.4

For analyses of causes of death, we used two surveys by the Chinese Ministry of Health, in 1973–75 and 2006,3 and the national system of disease surveillance points in 1991–2000.5 The 1973–75 death survey, which was also called the cancer epidemiology survey, covered 2392 counties or about 850 million people and included information from family members and medical records on causes of death by age and sex.6 Causes of death were classified into infectious diseases, pneumonia, tuberculosis, cancer (including main cancers such as lung cancer and stomach cancer), cerebrovascular diseases, chronic respiratory diseases, chronic bronchitis, hepatocirrhosis, other non-communicable disease, and injury. Causes of death were linked to standard International Classification of Diseases (ICD) according to the mapping table of ICD.9 Data from the 1973–75 survey were reported by age groups and causes. China has a system, based on disease surveillance points in 145 locations throughout the country, selected by multiple-stratified random sampling, which covers a 1% sample of China’s population. Between 1991 and 2000, this system recorded causes of death for 10 million people. This nationally representative sample reflected regional population distributions, urban and rural areas, age and sex, and eastern, middle, and western regions.9 After new legislation in 1992,10 a uniform certification procedure for cause of death is now in place for institutional deaths in China, based on the international format for cause of

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Chinese Centre for Disease
Control and Prevention,
Beijing, China (Prof G Yang MD,
W Zhao MD, Y Zhai MS); Bureau
of Disease Prevention and
Control, Ministry of Health,
China; (L Kong MD); Institute of
Basic Medical Sciences of
Chinese Academy of Medical
Sciences and School of Basic
Medicine of Peking Union
Medical College, Beijing, China
(G Yang, X Wan PhD); China
Medical Board, Cambridge, MA,
USA (L C Chen MD); Emory
Global Health Institute, Emory
University, Atlanta, USA
(J P Koplan MD)
Correspondence to:
Prof Gonghuan Yang, Chinese
Centre for Disease Control and
Prevention, 27 Nan Wei Road,
Xuanwu district, Beijing 100050,
China yanggh@chinacdc.cn
death. For deaths at home, causes of deaths are determined based on information provided by family members, with or without documentary medical evidence. Several studies have validated the causes of death reported by the system of disease surveillance points. The reliability of the data for death causes at a population level is a key issue in China, where not all deaths occur in hospitals or health establishments. The studies show that for major causes at least, ascertainment of cause of death is reasonably reliable. Every 3 years under-reporting is estimated by a survey that covers 5% of the surveillance population, and mortality estimates are adjusted accordingly. The data from disease surveillance points included more than half a million deaths with causes classified on ICD-9.

The disease surveillance points system was expanded in 2001, to cover 71.4 million people. Each point of the system has been expanded to a whole county, or district, to cover 300,000–700,000 people. A national death survey in 2006 checked the quality of reporting data of the expanded system by re-collecting causes of death during 2004–05. 868,484 cases of death from household inquiry were recorded. So-called verbal autopsies were used to characterise deaths without hospital diagnosis. About 6.44% of deaths were diagnosed by these instruments. Causes of death were classified according to the ICD-10. Data from the disease surveillance points system in 2004–05 were verified by the 2006 survey.

Mortality patterns have been described in three groups: communicable and maternal and perinatal conditions; non-communicable chronic diseases; and injuries. The chronic diseases include cancer, cardiovascular disease, diabetes mellitus, arthritis, cerebrovascular disease, and other conditions, following standard international classification systems.

Since causes of death were not classified according to ICD in the 1973–75 survey, we combined infectious diseases, tuberculosis, and pneumonia into communicable diseases. We compared data for causes of death in the 1991–2000 disease surveillance points survey and the 2006 survey based on the same standard. Trends for individual causes of death were analysed with disease surveillance points data, since they were collected with the same methods in the same population. The same codes for causes of death reported from 1991 to 2000 in the disease surveillance points data were used for the 2006 death survey, for purposes of comparison. To verify the increasing and decreasing trend of these diseases, we calculated age-standardised death rates in 2005 based on the population structure from China’s 2000 census.

Panel 1 summarises definitions for hypertension, smoking, obesity, and adults who are overweight. Risk factor data were sourced from three types of national surveys. Data on hypertension were obtained from national surveys in 1991 and 2002. Data on overweight people, obesity, and dietary intake were obtained from national nutrition surveys conducted in 1992 and 2002.

Panel 1: Definitions
Hypertension
Systolic blood pressure of 140 mm Hg or greater, diastolic blood pressure of 90 mm Hg or greater, or use of medicine to control blood pressure in the past 2 weeks. All blood pressure values were based on actual measurements.

Obesity
Body-mass index of 28 kg/m² or greater for adults aged 18 years and older. WHO uses 30 kg/m² as the threshold, and a threshold of 27 kg/m² has been recommended for Asia.

Overweight
Body-mass index of 24 kg/m² or greater for adults aged 18 years and older. WHO uses 25 kg/m² as the threshold, and a threshold of 23 kg/m² has been recommended for Asia.

Ever-smoker
A person who has smoked daily for at least 6 months during their lives.

Current smoker
A person who, at the time of the survey, smoked a tobacco product.

Passive smoker
A person who is exposed to smoke exhaled by a smoker for more than 15 min per day and more than once per week.

Data on tobacco use are from the national surveys on tobacco use in 1984–96 and 1996–2006, and from a national survey on risk factors for chronic disease in 2002.

Mortality pattern changed
Figure 1 shows life expectancy in China from 1945–49 to 1999–2000. Life expectancy increased after 1950, and especially quickly before 1975, because of successful control of infectious diseases and maternal and prenatal conditions. Since 1990, life expectancy has plateaued, in association with the emergence of chronic diseases. Life expectancy at birth increased from less than 50 years to nearly 70 years during the 40 years between 1950 and 1990. Between 1990 and 2000, however, life expectancy increased by only 2 years, from 70 to 72 years.

Mortality analysis has shown a parallel transition in the major causes of death in the past 30 years (figure 2). Whereas in 1973, communicable diseases and maternal and perinatal conditions accounted for 27.8% of deaths, that proportion had fallen to 5.2% by 2005. The converse trend was observed for chronic diseases: cerebro-cardiovascular diseases, chronic obstructive pulmonary disease, and cancers increased as a proportion of all deaths, from 41.7% in 1973 to 74.1% in 2005.

Surveillance data from 1991 to 2000 show the pace of these changes. The age-standardised death rate fell by 13% over this period. Age-standardised death rates for 17 individual causes (infectious diseases; tuberculosis;
The World Bank has projected that more than 400 million Chinese people could be older than 60 years by 2050. However, the substantial increases in age-standardised rates of death from the major chronic diseases suggest that an even more powerful force has driven the emergence of chronic diseases. This force is the rapid increase in high-risk behaviours. In China, the sheer scale of hypertension, increase in dietary fats, reduced physical activity, smoking, and other high-risk behaviours is noteworthy (table 2). Some of these risky behaviours demonstrate distinctive Chinese characteristics.

Dietary changes
Along with the substantial rise in people’s income during the rapid economic development of China over the past 20 years, the food supply and variety of food products has increased, with accompanying changes in dietary patterns. The intake of cereal decreased substantially over this period, whereas intakes of meat pneumonia; maternal and perinatal disorders; viral hepatitis; rheumatic heart diseases; cholelithiasis; hypertension; intentional self-harm; accidents caused by fire and flames; accidental drowning and submersion; accidental falls; accidental poisoning; congenital malformations, deformations, and chromosomal abnormalities; chronic obstructive pulmonary disease; oesophageal cancer; and liver diseases) decreased by more than 10%. Overall, the age-standardised rates of death for these 17 causes decreased by 91 people per 100 000 between 1991 and 2000. By contrast, the age-standardised rates of mortality for seven other causes of death increased by more than 10%. These causes were stroke, coronary heart disease, diabetes, lung cancer, liver cancer, breast cancer, and traffic accidents. The age-standardised rates of death from these causes increased by 40 people per 100 000 (from 172 per 100 000 in 1991 to 212 per 100 000 in 2000). These seven causes accounted for 38·5% of deaths in 2000. Figure 3 shows four causes of death that increased over this period (lung cancer, cerebrovascular disease, coronary heart disease, and diabetes) and three causes that decreased (infectious diseases, pneumonia, and perinatal disorders).

In China, patterns in causes of death have varied between urban and rural areas and between populations in the eastern, middle, and western regions of rural areas (table 1). Rural areas (especially in western regions) have had higher mortality from communicable diseases, maternal and perinatal conditions, chronic obstructive pulmonary diseases, and injuries. By contrast, urban areas have had higher death rates from cardiovascular heart disease and cerebrovascular diseases. The 2006 mortality survey showed that age-standardised death rates from lung cancer, breast cancer, and leukaemia were higher in urban than in rural areas, but that oesophageal cancer and cervical cancer were higher in rural than in urban areas. Urban and rural liver cancer mortality rates were similar.

**Behavioural risk factors**
Two major forces have been responsible for the emergence of chronic diseases in China. The first has been the very rapid transition of China’s population from a youthful to an ageing population as life expectancy has increased. This so-called greying of China’s population has increased causes of death associated with elderly populations. Birth rates have plummeted, and China’s one-child family policy has been a strong driver of population ageing. Whereas 7·6% of the population were aged 60 years and older in 1982, this proportion had grown to 10·5%, or 129 million, by 2000. The World Bank has projected that more than 400 million Chinese people could be older than 60 years by 2050.

Figure 1: Life expectancy at birth in some years in China
Data are from references 6 and 30.

Figure 2: Distribution of causes of death between 1973 and 2005
Data are from references 7–9.
Figure 3: Changing age-standardised cause of selected death rates 1991–2000
Data are from reference 9.
Domestic tobacco production has increased from 68·3 g per day in 1982 to 85·6 g per day for urban Chinese, and from 39·6 g to 72·6 g for rural Chinese.\(^{37}\) In both urban and rural areas, cereals decreased as a proportion of the diet, whereas fats increased. In 1982, cereals contributed 74·6% of energy intake in rural areas and fats constituted 25% of energy intake in urban areas.\(^{37}\) By 2002, cereals contributed 61·5% of energy intake in urban areas, and fats constituted 35% of energy intake in rural areas, and edible oil increased. Fat intake increased from 68·3 g per day in 1982 to 85·6 g per day for urban Chinese, and from 39·6 g to 72·6 g for rural Chinese.\(^{37}\)

In both urban and rural areas, calories per day have increased, with urban Chinese consuming 2491–2250 kcal per day and rural Chinese consuming 2251–2000 kcal per day.\(^{37}\) Calorie intake has increased steadily from 80 billion cigarettes in 1949, to 256 billion in 1968, 651 billion in 1979, 1630 billion in 1990,\(^{41,42}\) 256 billion in 1992, and 2022 billion in 2006,\(^{29}\) which is approximately twice that recommended by Chinese dietary guidelines.\(^{43}\) In some rural areas, average salt intake was as high as 14·7 g.\(^{29}\) Despite known health benefits, control of hypertension in China is far from optimum. According to the national nutrition survey of 2002, only 30% of adults with hypertension are aware of their condition.\(^{29}\) Of those 30%, only 6% manage their hypertension effectively, 6% are without treatment, and 19% treated their hypertension without gaining adequate control.\(^{36}\)

### Overweight people and obesity

By the WHO definitions, 18·9% of Chinese adults aged 18 years and older were overweight in 2002, and 2·9% were obese. However, by definitions used elsewhere in Asia, prevalences were higher, with 31% overweight people and 12·1% obese people in 2002.\(^{22,23}\) The Chinese Ministry of Health has recommended that people with a body-mass index of 24 kg/m\(^2\) or more should be considered overweight, and that those with an index of 28 kg/m\(^2\) or more should be considered obese. Based on these thresholds, 22·8% of Chinese people were overweight in 2002, and 7·1% were obese. The proportion of overweight adults increased by 39% between 1992 and 2002, based on the Chinese threshold, whereas the proportion of obese people increased by 97%. In large cities, 13% of children and adolescents aged 7–17 years were overweight, and 8% were obese.\(^{22,24}\)

The average daily calorie intake of both urban and rural Chinese has changed little over the past two decades. Calorie intakes of 2491–2250 kcal per day were reported in 1982, 1992, and 2002.\(^{25,26}\) This suggests that the increases of overweight people and obesity have been mainly caused by reduced physical activity. 49% of Chinese people reported that their physical activities decreased over a 10-year period.\(^{22}\) The average time that Chinese adults spent watching television every day was 2·1 h, and risks for gaining weight have been associated with time spent watching television.\(^{22}\) Only 15% of urban Chinese adults exercised regularly in 2002.\(^{29}\)

### Tobacco use

China is the largest tobacco grower and consumer in the world.\(^{26}\) One in every three smokers in the world is a Chinese man.\(^{27,28}\) Domestic tobacco production has steadily increased from 80 billion cigarettes in 1949, to 256 billion in 1968, 651 billion in 1979, 1630 billion in 1990,\(^{29}\) and 273 billion in 2002. Consumption of cigarettes increased to 2022 billion in 2006,\(^{29}\) 17·4% higher than in 2002. 99·2% of domestically produced cigarettes are consumed in China and only 0·8% are exported.\(^{44}\) Average consumption for Chinese men has increased from 13 cigarettes per day in 1984 to 15 cigarettes per day in 2002.\(^{44}\)

Figure 4 show that in 1996 and 2002, more than 60% of men older than 25 years were smokers. Rates of smoking...
were much lower for women. Smoking was most prevalent in elderly women in 1996, at 15% in those over 65 years, but had reduced by 2002. However, the large proportion of male smokers in China has been high and stable for the past two decades—with smoking prevalence of 61% in 1984,36 63% in 1996,27 and 57% in 2002.2 Cultural and social factors have discouraged tobacco use in Chinese women.41 The average age of initiation to smoking fell to 18 years for men in 2002, compared with 22 years in 1984, and women were also introduced at a younger age (20 years, compared with 25 years).25,29 Passive exposure to tobacco smoke affects 52·2% of the Chinese population, and did not change between 1996 and 2002. 82% of passive smokers reported exposure at home; 35% at their workplace; and 67% in public places.9

Responding to chronic disease
These data show that China has completed the epidemiological transition from a predominance of infectious diseases and maternal and perinatal conditions to chronic diseases and injury. Whereas non-communicable diseases constituted 58·2% of all deaths in 1973–75, the proportion had increased to 73·8% in 1991. By 2000, 82·9% of all deaths were due to non-communicable diseases, corresponding to the loss of about 70% of all disability-adjusted life-years.44

Unfortunately, the prevalence and burden of chronic diseases will probably continue to grow. China’s ageing population structure will inevitably produce higher ratios of the chronic diseases that are commonly seen in older age groups. But rises in the rates of death from stroke, coronary heart diseases, diabetes, lung cancer, liver cancer, and breast cancer also show the importance of changing behavioural risk factors—high dietary intake of salt, increasing intake of fats, and decreasing intake of cereal and reduced physical activities. The rate of these changes in high-risk behaviour and the early age at which they begin, are of especial concern.

The direct and indirect economic costs of chronic diseases are already substantial, and are likely to grow. Direct costs include expenditures for admissions to hospital; medical costs; costs of prevention; and care-related travel, nursing, and family support. Indirect costs come from lower productivity, sick leave, loss of productive workers from early retirement, premature deaths, and time lost by family members. These costs are heavy and can cause impoverishment. Surveys on use of health care in 2003 showed that the average medical fee for treatment of inpatients with hypertension, diabetes, coronary heart diseases, stroke, and cancer was 4000–10000 Chinese Renminbi (7 Renminbi=US$1),46 in comparison with the average urban income of 9422 Renminbi per year, and 2936 Renminbi for a rural family.46 Inpatient treatment for common chronic diseases, therefore, could cost over half of annual income for urban residents and up to three times the annual income of rural residents. Surveys in 2003 showed that the direct cost of admissions to hospital for patients with ischaemic stroke was 10·7 billion Renminbi. Total expenditure on ischaemic stroke was 19·8 billion Renminbi, which accounted for 3·0% of the entire national health expenditure.47

Both the health burden of chronic diseases and their economic burden exert pressure for China’s recently launched health-care reforms; these burdens also prioritise certain aspects of these reforms. The demand for healthcare services for chronic diseases can drive use of high-cost advanced technologies in tertiary facilities. Risk pooling of health-care financing to mitigate the effects of out-of-pocket payments for treatment of chronic diseases should be a priority in terms of public need and health equity. Tighter integration of primary, secondary, and tertiary care services should also be a priority, to channel treatment of chronic diseases to the most cost-efficient levels of the health-care system. Reform efforts must avoid bypassing primary facilities for more expensive tertiary facilities. Care of chronic diseases will profoundly challenge China’s home-based system for rehabilitation. Family-care systems are likely to become more fragile, because of the increasingly elderly population, one-child families, dual roles of Chinese women as both workers
Although the focus of the medical community on service appropriate prevention strategy for chronic diseases. Treatment of individuals in the health sector is another diseases that now cause a high proportion of deaths. to realign established strategies for control of infectious strategies will need to be strengthened. Institutional reforms will be needed health prevention and disease control systems will need including television.

Social welfare, housing, education, and the mass media, other sectors such as employment, income maintenance, these policies can no longer be isolated from policies in these strategies will need to be supported by public policies. These policies can no longer be isolated from policies in other sectors such as employment, income maintenance, social welfare, housing, education, and the mass media, including television.

To undertake these prevention activities, China’s health prevention and disease control systems will need to be strengthened. Institutional reforms will be needed to realign established strategies for control of infectious diseases and combat the emergence of the chronic diseases that now cause a high proportion of deaths. Treatment of individuals in the health sector is another appropriate prevention strategy for chronic diseases. Although the focus of the medical community on service to high-risk patients benefits individuals, effective long-term prevention will also need a much wider, multisectoral commitment. Social action is one of the most important strategies to reduce non-communicable diseases. Reducing non-communicable disease is the key intervention for reduction of poverty, and the reduction of social inequalities and inequities in health. Social actions need to include mobilisation of allied sectors, including transport (to address the growth in automobile use and less friendly environments for cycling and pedestrians); education (to enhance comprehensive school-based health education and promotion); fiscal policy (to increase tobacco taxes); regulatory action (to ensure food safety and content, and prohibit smoking in public places); and urban design (to provide parks, green spaces, and paths for bicycles and walkers).

Addressing major risk factors for chronic diseases should be given the highest priority. Prevention should focus on combating risk factors in an integrated manner at the level of family and community, to tackle deeply entrenched social and cultural factors. The Ministry of Health must develop its skills and capabilities more broadly than the biomedical sciences. For example, hypertension and tobacco can be targeted as behavioural health priorities. Reduction of salt intake should become a national campaign, including dietary guidelines and food labelling. Blood pressure measurement should be measured at all health encounters, and non-traditional opportunities for measurement (such as in shopping areas and recreational sites) should be identified.

The Ottawa Charter for health promotion has pointed out that one important strategic action for health promotion is to build healthy public policy, which is the responsibility of government. For example, China has adopted the Framework Convention of Tobacco Control, but for effective implementation this needs to be translated into policy, including increased taxes and prices for cigarettes, protection of non-smokers from second-hand smoke, prohibition of advertisements for cigarette products, regulation of the contents of tobacco products, and information and disclosures in the packaging and labelling of tobacco products.

China has had some successes in the control of chronic diseases in pilot programmes, for example stroke prevention (panel 2). A pilot project to target smoking in seven Chinese cities reduced the prevalence of smoking in men from 70% to 55%, increased cessation of smoking from 15% to 22%, and decreased exposure to second-hand smoke from 1996 to 2002. Replication of these small-scale pilot interventions at larger scale is feasible. Lessons from other countries could also be applied in China, such as a population-based multifocal intervention in Finland, which reduced mortality from cardiovascular heart disease. Continued surveillance of the levels and pattern of risk factors will be fundamental to assessment of activities to prevent
and control non-communicable diseases. Chinese Centre for Disease Control should develop more robust systems for surveillance and data analysis, and provide more evidence-based guidelines for nationwide control of non-communicable diseases.

Just as China was able to control infectious diseases within a shorter time than other countries, it has the opportunity today to reduce the time over which chronic diseases take a high health and economic toll in the country. China’s early and substantial success in control of infectious diseases was achieved by prevention strategies; prevention will also be an urgent strategy that can be implemented both within China’s public-health structure and by practitioners of clinical care. Prevention and control of chronic diseases is a large and complex task, but no more so than many of the challenges that have confronted China in its long history, and especially in its last 50 years. China can build on its health, economic, educational, and development successes and address the challenge of chronic diseases and their risk factors. In so doing, it might provide insights and approaches for other nations to adopt in improving the health of their populations.

Contributors
GHY, LCC, and JPK participated in the conception, writing, and discussion of the paper. LKZ and WHZ took part in the writing and discussion of the article. XW and YZ participated in data analysis and discussion of the article. All authors have seen and approved the final version.

Conflict of interest statement
We declare that we have no conflict of interest.

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