



# Trends in smoking prevalence and attributable mortality in China, 1991–2011



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## ABSTRACT

**Objective.** China is the largest producer of tobacco worldwide. We assessed secular trends in prevalence of smoking, average cigarettes per day, mean age of initiation, and mortality attributable to smoking among the Chinese population between 1991 and 2011.

**Design.** Data came from the China Health and Nutrition Survey, conducted eight times between 1991 and 2011. A total of 83,447 participants aged 15 years or older were included in this study. Trends in smoking were stratified by sex, age, and region (urban vs. rural).

**Results.** In 2011, 311 millions individuals were current smokers in China, with 295 million men and 16 million women, respectively. Between 1991 and 2011, the prevalence of current smoking decreased from 60.6% to 51.6% in men, and from 4.0% to 2.9% in women. However, during this period, the average number of cigarettes smoked per day per smoker increased from 15.0 to 16.5 in males, and from 8.5 to 12.4 in females. Further, age of smoking initiation decreased from 21.9 to 21.4 years in men and from 31.4 to 28.4 years in women. In 2011, 16.5% of all deaths in men and 1.7% in women were due to smoking. Between 1991 and 2011, the total number of deaths caused by smoking increased from 800,000 to 900,000.

**Conclusions.** During the past 20 years, a slight decrease in smoking prevalence was observed in the Chinese population. However, cigarette smoking remains a major cause of death in China, especially in men.

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## 1. Introduction

Cigarette smoking is the leading risk factor for many non-communicable diseases and premature mortality worldwide (Chen et al., 2015; WHO, 2015). Tobacco use was responsible for 4.8 million deaths in 2000 and 6.0 million in 2011 worldwide (Asma et al., 2014; Ezzati and Lopez, 2003). By 2030, tobacco use is expected to cause 8.3 million deaths, accounting for 10% of the all-cause mortality globally (Mathers and Loncar, 2006). China is the largest tobacco producer worldwide. The number of cigarettes produced in China increased from 0.5 trillion in 1980 to 2.6 trillion in 2013, corresponding to 43% of the current world's tobacco production. 99% of cigarettes produced in China are consumed domestically and only 1% exported (Yang et al., 2008). It has been estimated that >300 million adults were smokers in

China, accounting for a third of the world's total number of smokers (No authors listed, 2011). As a result, China bears tremendous economic and disease burdens attributable to smoking. In 2008, smoking was estimated to have cost China about \$5 billion for treatment of smoking-related diseases (direct costs) and \$29 billion in total economic lost (direct and indirect costs) (No authors listed, 2014b; Yang et al., 2011). Tobacco has been estimated to account for 9.5% of disability-adjusted life-years and 16.4% of deaths among Chinese adults (Koplan et al., 2010; Yang et al., 2013).

In consideration of the great number of smokers and the large health hazard attributable to smoking, the Chinese government has adopted a wide range of interventions to curb tobacco use, including tax increases, bans on advertising, and smoke-free laws. Furthermore, the Chinese government ratified the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) in 2005. Despite these efforts, a number of serious challenges remain. The Global Adults Tobacco Survey (GATS) showed that 28.1% of Chinese adults (52.9% of men and 2.4% of women) were current smokers in 2010 (Li et al., 2011). In addition, among the 16 countries that had completed the survey, China ranked second for smoking among men, between Russia (60.2%) and Ukraine (50.0%) (Giovinio et al., 2012).

**Abbreviations:** CHNS, China Health and Nutrition Surveys; FCTC, Framework Convention on Tobacco Control; GATS, Global Adults Tobacco Survey; RR, Relative risk; WHO, World Health Organization.

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In China, patterns of tobacco use have evolved along social and economic development and progress of implementation of tobacco control policies. However, only few studies have documented trends in smoking and the impact on mortality in the Chinese population (Chen et al., 2015; Giovino et al., 2012; Gu et al., 2009; Lam et al., 1997; Qian et al., 2010). Monitoring trends in smoking and its impact is critical for policy makers in order to guide appropriate tobacco control interventions. Hence, based on data of successive national Chinese surveys (the China Health and Nutrition Surveys, CHNS), we assessed secular trends in smoking, average number of cigarettes smoked daily, mean age of smoking initiation, and mortality attributable to smoking in the Chinese population between 1991 and 2011.

## 2. Methods

### 2.1. Study design and subjects

The CHNS is designed as a national, large scale survey to examine the health and nutritional status of the Chinese population over time. It is an international collaborative project between the Carolina Population Center of the University of North Carolina and the National Institute of Nutrition and Food Safety of the Chinese Center for Disease Control and Prevention since 1989. Surveys are carried out using a multistage random cluster sampling strategy to obtain population based data in nine Chinese provinces (Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guizhou and Guangxi), which vary in geography, economic status, public resources, and health indicators. Detailed information of CHNS has been published elsewhere (Popkin et al., 2010).

Between 1991 and 2011, a total of 83,447 participants aged 15 years or older in eight surveys (9394 in 1991, 8784 in 1993, 11,149 in 1997, 10,116 in 2000, 10,313 in 2004, 10,099 in 2006, 10,278 in 2009, and 13,314 in 2011) were included in data analyses. Characteristics of the survey participants are shown in the Supplemental Table 1. The participation rate was >98% in each survey.

Written informed consents were obtained from all participants. This study was approved by the Institutional Review Board from both the University of North Carolina at Chapel Hill and the China Center for Disease Control and Prevention.

### 2.2. Definitions

Between 1991 and 2011, smoking habits were assessed by 4 questions that were kept identical in each survey. The first question was "Have you ever smoked cigarettes (including hand-rolled, device-rolled or pipe)?" Responses included "never smoked" and "yes". The second question was "Do you still smoke cigarettes now?" Participants who answered "yes" were defined as "current smoker". The third question was "How many cigarettes do you smoke per day?". The fourth question was "How old were you when you started to smoke?".

### 2.3. Statistical analysis

Categorical variables were expressed as percentage (SE), while continuous variables were presented as mean (SE). The estimates of current smoking or ever smoking, number of cigarettes used per day and the initiation age by sex, age, and region are described in this study. The sex- and age- specific China census distribution of the population in 2010 was used to standardize estimates in all surveys. Trends in prevalence of current smoking and ever smoking between 1991 and 2011 were examined using multiple logistic regression adjusted for sex, age and region; trends in number of cigarettes smoked per day and age of smoking initiation were assessed by similarly adjusted multiple linear regression. To calculate the population attributable risk (PAR) of smoking, we used the following formula:  $PAR = (P \times [RR - 1]) \div (P \times [RR - 1] + 1)$ , where P is the prevalence of smokers, and RR is the relative risk of disease or mortality (Gu et al., 2009). Estimates

for RRs for all-cause mortality, cancer, respiratory disease and cardiovascular disease were extracted from a publication by Chen et al. (2015). All data were analyzed using the statistical package SPSS (version 16.0). Two-side *p* values of <0.05 indicated statistical significance.

## 3. Results

Supplemental Table 1 presents characteristics of the study populations in each survey between 1991 and 2011. There were differences across the eight surveys, with increasingly old and urban populations. Table 1 shows trends in prevalence of current smoking by sex, age, and region between 1991 and 2011. In 2011, it was estimated that 311 millions individuals were current smokers in China, with 295 million men and 16 million women, respectively. The prevalence of smoking decreased from 1991 to 2011 in both sexes, i.e., from 60.6% to 51.6% in men and from 4.0% to 2.9% in women, respectively (for both sexes, *p* for trends <0.001) (Fig. 1A). Decreasing prevalence was found in all age and region (urban/rural) subgroups (*p* for trend <0.001) except for younger women aged 15–24 years for which the decrease did not reach statistical significance (*p* = 0.223).

The prevalence of current smoking was highest for men aged 25–44 years old and 45–64 years old. In women, prevalence of smoking was much lower compared with men in each survey year; in 2011, the prevalence ratio of smokers was 1 woman for 18 men. In men, the prevalence of smoking was slightly higher in rural than urban areas in a consistent manner between 1991 and 2011. In women, while the prevalence was higher in urban than rural areas until 2004, the urban-rural difference vanished thereafter. For the prevalence of ever smoking, similar trends were found in the total population and in sex, age and region subgroups (Supplemental Table 2 and Fig. 1B). In addition, during the period of 1991 to 2011, the prevalence of former smoking increased from 3.7% to 8.4% in men, while it remained stable at 0.5% in women.

Among current smokers, the number of cigarettes smoked per day increased from 15.0 to 16.5 in men and from 8.5 to 12.4 in women (Supplemental Table 3 and Fig. 1C). Similar upward trends were found in most age and region subgroups. In men, subjects aged 45–64 years experienced the highest increase in mean number of cigarettes smoked per day among all four age groups. In women, the greatest increase occurred in subjects aged 25–44 years.

The mean age of smoking initiation declined in the whole population and in most age and region subgroups between 1991 and 2011 (for most subgroups, *p* for trends <0.001). We restricted this analysis to subjects aged 25 years or older as the daily smoking rates were not stable for individuals aged 15–24 years. The decrease was more important in women (from 31.4 to 28.4 years old; difference of 3.0 years) compared to men (from 21.9 to 21.4 years old; difference of 0.5 years) (Supplemental Table 4 and Fig. 1D). In each survey, mean age of initiation was lower for men than women. Furthermore, mean age of initiation was lower for rural than urban female smokers while no obvious region difference was found in male smokers.

In China, the total number of deaths from any cause increased from 5.9 million in 1990 to 7.0 million in 2010 (Yang et al., 2015). In 2011, the proportion of deaths due to smoking (i.e., the population attributable risk) was 16.5% in men and 1.7% in women. When applied to the whole population, this proportion corresponds to 900,000 deaths (800,000 in men and 100,000 in women). Between 1991 and 2011, the proportion of deaths due to smoking slightly decreased because of the small reduction in smoking prevalence on both sexes (Table 2). However, the number of deaths attributable to smoking increased markedly, from 800,000 in 1991 to 900,000 in 2011 (men: 700,000 to 800,000; women: 100,000 to 100,000).

## 4. Discussion

In 2011, smoking remained common in the Chinese population (about 311 millions current smokers), especially in men. Between

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