# THE DECLINE OF SMOKING IN CHINA FROM 1989 TO 2009:

# SHIFTING COMPOSTION OR BEHAVIOR?

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## ABSTRACT

It has been reported that smoking among Chinese men declined significantly over recent decades. We assess this trend and track factors contributing to it. We use the triple standardization method, focusing on whether changes in smoking are due to shifts in the composition of men (i.e., age structure, education, and residence) or due to shifts in the inclinations of men to smoke. A decline in smoking among Chinese men is found to be a real historical change and not an artifact of survey methodology. Shift in the inclinations of men to smoke, more specifically, the decrease in the proportion of men who have ever smoked, accounts for the most of the decline. The contributions of changes in the composition of men are small.

It has been reported that smoking among Chinese men aged 15 or older declined significantly in recent decades, from 61% in 1984 to 53% in 2010 (Weng et al. 1987; Li et al. 2011). If true, a declining trend is welcome news to the general public and policy makers alike, since smoking has harmful effects on humans' physical, social, and economic well-being. Cigarette smoking is a major cause of morbidity and mortality in China (Yuan et al. 1996; Chen et al. 1997; Lam et al. 1997; Liu et al. 1998; Niu et al. 1998; Lin et al. 2008; Gu et al. 2009; Jiang et al. 2010), and its adverse health effects constitute a huge economic burden on Chinese society (Sung et al. 2006). It is estimated that by 1990 smoking accounted for about 12% of all deaths in males ages 35-69, and by 2030 it will probably account for one third if current smoking patterns persist (Peto et al. 2009). Moreover, smoking is also associated with reductions in human capital investment, future productivity, and financial security (Wang et al. 2006), and hence with an increase in poverty (Hu et al. 2005; Liu et al. 2006). In this article, we seek to evaluate whether or not a declining trend has truly occurred in China and track factors contributing to it during the past twenty years.

Trends in the prevalence of smoking may result from changes in the composition of men, such as age structure, education, and residence. A change in age distribution may contribute to the declining trend, given the well-known age patterns of smoking rates among Chinese men: the prevalence of current smoking rises steeply in their mid-10s and early 20s, remains at a high level in 30-40s, and then declines gradually thereafter (Weng et al. 1987; Li et al. 2011). As is well known, China's population has become older over its recent history due to its one-child family planning policy (Peng 2011). Education and urban/rural residence are found to be related to the probability of smoking, respectively. In China, the average length of education has increased remarkably in recent decades. The level of urbanization has greatly enhanced as well.

However, the inclinations of men to smoke may also change, which may contribute to the decline of smoking. Lopez, Collishaw, and Piha (1994) proposed a four-stage model of cigarette consumption trends in developed countries: males' smoking prevalence rises rapidly from a low level in stage 1 to a peak at the end of stage 2, then starts to decline, somewhat rapidly in stage 3 and more gradually in stage 4. The diffusion of innovations perspective attempts a more explanatory approach by subsuming tobacco adoption and use under this broader set of models which seek to track "an innovation, defined as an idea, practice, or object perceived as new by an individual or other relevant unit of adoption, which is communicated through certain channels over time among the members of the social system" (Rogers 1976:292). As Wejnert (2002) notes, such communication and influence alter an actor's probability of adopting an innovation and in a broad sense, studies of diffusion provide an empirical and quantitative basis for developing more rigorous approaches to theories of social change. Diffusion of innovation models call attention to the ups and downs of tobacco use within a population.

To date, no research systematically examines the determinants of smoking over the past two decades with an eye to parsing out the contributions of shifting demographic composition and changing inclinations or behavior. Using data from the China and Health Nutrition Survey, our analysis examines the trend closely and conduct a decomposition analysis to determine which factors have been most important in explaining the trend in the prevalence of current smoking among Chinese men.

## METHODOS

### *Data*

This study is based on analysis of data from the China Health and Nutrition Survey (CHNS), an ongoing project conducted by the Carolina Population Center at the University of North Carolina

at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention. The CHNS is a panel survey, which has collected eight waves of data so far (1989, 1991, 1993, 1997, 2000, 2004, 2006, and 2009). Although the CHNS data are not nationally representative, households were randomly selected from a set of provinces which are diverse in terms of geographic location, economic development, and public resources (A detailed description of the data and quality control procedure can be found at http://www.cpc.unc.edu/projects/china). Previous studies show that the characteristics of the CHNS households and individuals are comparable to those from national samples.[22, 23]

The CHNS initially covered eight provinces in China: Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, and Guizhou. In 1997, Liaoning province was replaced by Heilongjiang, a province similar to Liaoning in terms of geographic and other characteristics. From 2000 on, Liaoning was included in the survey again, along with Heilongjiang. We include all of these provinces in our analysis. A multistage, cluster sampling method was used to draw households in each province. The survey is not truly panel in design, as it included new households in each survey wave to replace those that were lost to follow-up. For simplicity, we treat the different waves of the survey as if they were repeated cross-sectional surveys.

For our study, we exclude the 1989 CHNS because it did not collect information about the smoking behavior of the respondents. From 1991 on, each wave of the survey asked whether the respondent had ever smoked a cigarette or a pipe. For an ever smoker, it further inquired whether he or she was also a current smoker. These survey questions afford us an opportunity to perform a decomposition analysis of trend in smoking prevalence. We restrict our analysis to men between 20 and 69 years of age at the time of the survey. After excluding invalid or incomplete

cases, our analytical sample consists of 3,724 men in 1991, 3,549 in 1993, 4,637 in 1997, 4,130 in 2000, 4,195 in 2004, 4,084 in 2006, and 4,227 in 2009.

We conduct an analysis for the country as a whole and by three key covariates, rural or urban residency, education, and region. Because China is a large country with significant variations in population age structure, socioeconomic development, and mortality, any generalization based on the analysis of the country as a whole might mask variations in smoking behaviors by subgroups. Region is a three-category classification highly correlated with economic development: East (Liaoning, Jiangsu, and Shandong), Middle (Heilongjiang, Henan, Hubei, and Hunan), and West (Guangxi and Guizhou). Appendix Table A1 presents descriptive statistics for variables used in this study by year.

***Decomposition Method***

We use the triple standardization method to decompose the prevalence of current smoking. The equation for the decomposition is presented below.

$$CSR_t = \sum W_t(x) s_t(x)[1 - c_t(x)]/P_t \quad (1)$$

$$= \sum g_t(x) s_t(x)[1 - c_t(x)],$$

where $CSR_t$ is the crude current smoking rate in year $t$, $W_t(x)$ is the number of persons aged $x$ in year $t$, $P_t$ is the total population in year $t$, $g_t(x)$ is the proportion of persons aged $x$ in the total population in year $t$, $s_t(x)$ is the proportion of ever-smokers for persons aged $x$ in year $t$, and $c_t(x)$ is the proportion of quitters among ever-smokers aged $x$ in year $t$.

Define $\delta g(x) = g_{t2}(x) - g_{t1}(x)$, $\delta s(x) = s_{t2}(x) - s_{t1}(x)$, $\delta c(x) = c_{t2}(x) - c_{t1}(x)$. We then can decompose the change in $CSR$ between $t_1$ and $t_2$, $\delta CSR$, as follows:

$$\delta CSR = CSR_{t2} - CSR_{t1} \quad (2)$$

$$=\sum g_{t2}(x)s_{t2}(x)[1-c_{t2}(x)]-\sum g_{t1}(x)s_{t1}(x)[1-c_{t1}(x)]$$

$$=\sum[g_{t1}(x)+\delta g(x)]\,[s_{t1}(x)+\delta s(x)][1-c_{t1}(x)-\delta c(x)]$$

$$-\sum g_{t1}(x)s_{t1}(x)[1-c_{t1}(x)]$$

$$=\sum \delta g(x)s_{t1}(x)\,[1-c_{t1}(x)]+\sum g_{t1}(x)\,\delta s(x)[1-c_{t1}(x)]+\sum g_{t1}(x)\,s_{t1}(x)[-\delta c(x)]$$

$$+\sum \delta g(x)\delta s(x)\,[1-c_{t1}(x)]+\sum \delta s(x)[-\delta c(x)]\,g_{t1}(x)+\sum \delta g(x)[-\delta c(x)]\,s_{t1}(x)$$

$$+\sum \delta g(x)\delta s(x)[-\delta c(x)].$$

The first three terms in equation (2) are called main effect terms. Each of them corresponds to the independent impact, *ceteris paribus*, of a change in age structure, ever-smoking, or smoking-cessation on the crude current smoking rate. The second three terms and the last one are two-way and three-way interaction terms. When $\delta g(x)$ , $\delta s(x)$ , and $\delta c(x)$ are relatively small, compared with the initial values of $g(x)$ , $s(x)$ , and $c(x)$, the interaction terms are negligible, which gives us

$$\delta CSR \approx \sum \delta g(x)\,s_{t1}(x)[1-c_{t1}(x)]+\sum g_{t1}(x)\,\delta s(x)[1-c_{t1}(x)]+\sum g_{t1}(x)\,s_{t1}(x)[-\delta c(x)]. \quad (3)$$

The above expression implies that we use the cross-products of $g_{t1}(x)$, $s_{t1}(x)$, and $c_{t1}(x)$ as the standard in our standardization analysis. The decompositions enable us to estimate the separate effects of changes in age structure, ever-smoking, and smoking-cessation on trends in current smoking among Chinese men.

To isolate the effect of changes in education distribution, we use the similar triple standardization method to decompose the prevalence of current smoking into the following three parts: changes in education distribution, ever-smoking, and smoking-cessation. To isolate the effect of changes in urbanization, we use the similar triple standardization method to decompose

the prevalence of current smoking into the following three parts: urban/rural residence, ever-smoking, and smoking-cessation.

## RESULTS

### Trends in Smoking

We first show, in Figure 1, a sharp decline in current tobacco smoking among Chinese men aged 20-69 between 1991 and 2009. The circles represent the observed percentage of current smokers in each wave, marked with 95 percent confidence intervals (adjusting for survey sampling effects). The heavy dark line represents a linear regression line that summarizes the overall year-to-year trend after smoothing. Between 1991 and 2009, the total amount of change is 12.6 percentage points, or 0.70 percentage point per year.

**[Figure 1 about Here]**

As in many western developed countries,[24-27] smoking tends to be negatively associated with socioeconomic status (SES) in China. Chinese society is stratified by strong, state-sponsored structural forces, such as *hukou* (household registration system)[28, 29] and region (i.e., East, Middle, and West)[30]. People with higher levels of education, living in urban areas, or living in eastern areas, are socioeconomically advantaged, and their prevalence of current smoking is consistently lower. However, the downward trend in smoking that we reported in Figure 1 is true for each SES subgroup, shown in Table 1. In 1991, 67.5% of urban men and 72.5% of rural men were current smokers; by 2009, the figures had fallen respectively to 55.8% and 58.5%. Likewise, the decreasing trend applied to both educational groups. The prevalence of current smoking declined from 67.7% to 55.4% among the more educated, and from 71.9% to 60.7% among the less educated. Smoking prevalence also declined across all regions from 1991 to 2009;

from 68.3% to 55.3% in the East, from 70.3% to 55.1% in the Middle, and from 71.9% to 63.4% in the West.

**[Table 1 about here]**

**Compositional Change or Behavior Change**

Next, we report results from a decomposition analysis to determine the relative contributions to the trend of the three factors that we earlier identified: age distribution, ever-smoking, and smoking-cessation, shown in Table 2. For these results, we used the standardization technique described in Equations (1)-(3). The main effects of the three factors on 1991-2009 overall trends are: 0.2% due to age structure, 11.8% due to ever-smoking, and 1.9% due to smoking-cessation. Therefore, the results reveal that the decrease in the proportion of men who ever smoked and the increase in smoking cessation are the first and second most important factors accounting for the overall decline in the prevalence of current smoking among Chinese men. The changing age structure was also conducive to the decrease in smoking prevalence, but its contribution is much less important.

**[Table 2 about Here]**

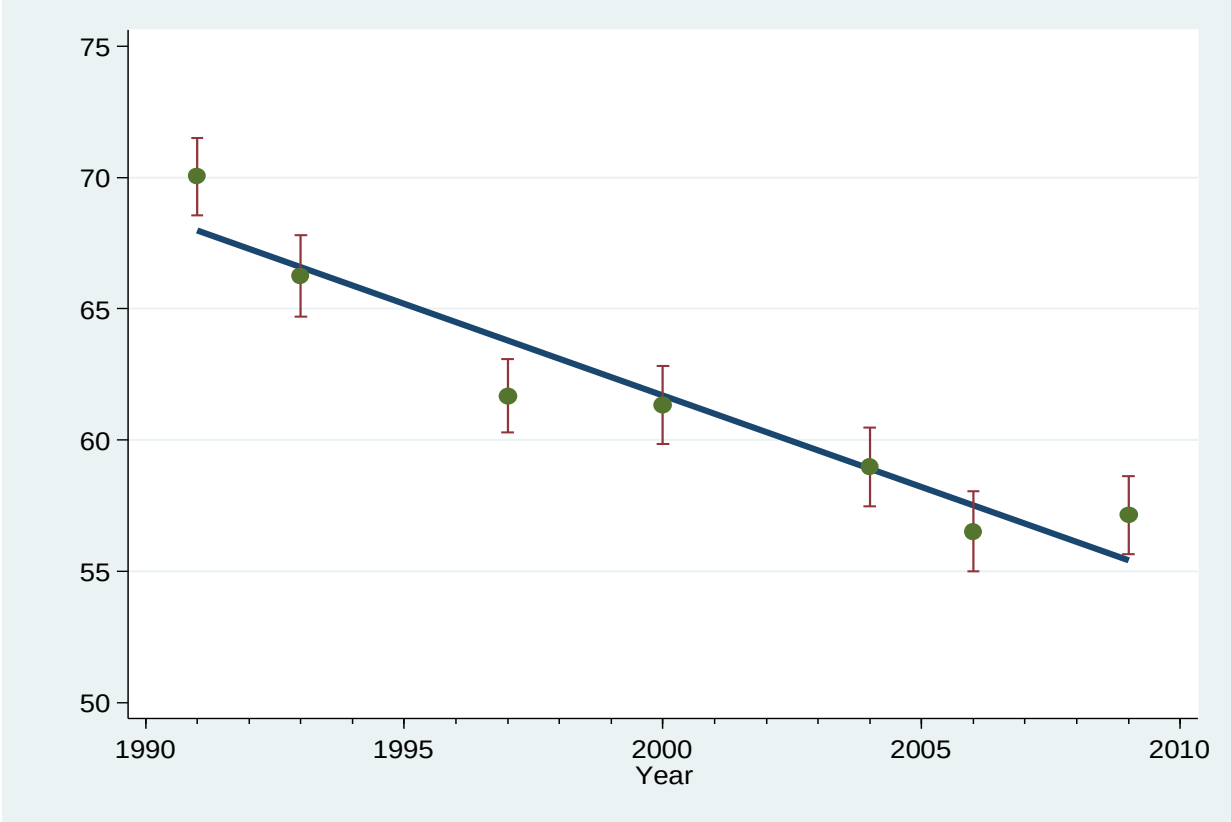
We also report the decomposition results by subgroup in Table 2. Declines in ever-smoking brought about the largest reduction in current smoking between 1991 and 2009 for all subgroups, between 9.3 percentage points and 15.1 percentage points. In general, the amount of reduction in current smoking attributable to ever-smoking was generally greater for a high SES group than for a low SES group. Similarly, increases in quitting smoking accounted for a larger reduction in current smoking among the more educated (2.4%) than among the less educated (0.6%), and among men living in the East (4.1%) than among men living in the Middle (3.0%) and among

men living in the West (2.4%). Perhaps for cost reasons, the reduction due to quitting was lower in urban China (1.5%) than in rural China (4.1%). With this exception, however, the patterns in the subgroup analysis suggest that reductions due to both ever-smoking and smoking-cessation, two major factors for the decline of current smoking, are more pronounced for high-SES groups than for low-SES groups. We suspect that this is because high-SES groups have reacted more responsively to health promotion campaigns about the hazards of smoking.

In the future work, we will continue to present the decomposition results that determine the relative contributions to the trend of the three factors: education distribution, ever-smoking, and smoking-cessation.

Moreover, we will also present the decomposition results that determine the relative contributions to the trend of the three factors: rural/urban residence, ever-smoking, and smoking-cessation.

**Figure 1. Percentage of Current Smokers among Chinese Men Ages 20 to 69 by Year**




*Source*: China Health and Nutrition Survey (1991, 1993, 1997, 2000, 2004, 2006, and 2009). N= 28,546
*Note*: Observed data are smoothed by a linear function (*b*=-0.698).

**Table 1. Percentage of Current Smokers among Chinese Men Ages 20 to 69 by Year and Selected Categories**

| | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 |
|---|---|---|---|---|---|---|---|
| *Residence* | | | | | | | |
| Urban | 67.5 | 64.2 | 58.6 | 58.7 | 57.1 | 55.5 | 55.8 |
| Rural | 72.5 | 68.1 | 64.4 | 63.9 | 60.7 | 57.5 | 58.5 |
| *Education* | | | | | | | |
| ≥9 years of schooling | 67.7 | 63.9 | 58.2 | 59.3 | 57.9 | 54.9 | 55.4 |
| <9 years of schooling | 71.9 | 68.2 | 65.8 | 64.1 | 60.6 | 59.2 | 60.7 |
| *Region* | | | | | | | |
| East | 68.3 | 63.0 | 57.0 | 58.8 | 56.5 | 54.4 | 55.3 |
| Middle | 70.3 | 65.6 | 60.1 | 60.7 | 58.9 | 56.1 | 55.1 |
| West | 71.9 | 71.2 | 68.4 | 66.3 | 62.4 | 60.2 | 63.4 |

*Source*: China Health and Nutrition Survey (1991, 1993, 1997, 2000, 2004, 2006, and 2009)

**Table 2. Decomposition of the Decrease in the Crude Current Smoking Rates among Chinese Men Ages 20 to 69 between 1991 and 2009, by Selected Categories**

| Absolute change (per 100) | Total | Age structure | Ever smoking | Smoking cessation | Interaction |
|---|---|---|---|---|---|
| *Total* | -12.9 | -0.2 | -11.8 | -1.9 | 1.0 |
| *Residence* | | | | | |
| Urban | -11.7 | -1.7 | -11.8 | -1.0 | 2.8 |
| Rural | -14.0 | 1.9 | -12.6 | -3.0 | -0.2 |
| *Education* | | | | | |
| ≥9 years of schooling | -12.3 | -1.4 | -11.8 | -1.6 | 2.6 |
| <9 years of schooling | -11.2 | -2.1 | -10.2 | -0.5 | 1.5 |
| *Region* | | | | | |
| East | -13.0 | -1.8 | -11.0 | -2.8 | 2.7 |
| Middle | -15.2 | 0.2 | -15.1 | -2.1 | 1.8 |
| West | -8.5 | 0.9 | -9.3 | -1.7 | 1.7 |

*Source*: China Health and Nutrition Survey (1991 and 2009)

## APPENDIX

**Table A1. Descriptive Statistics for Variables Used in This Study by Year: Chinese Men Ages 20-69**

| | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1991 | 1993 | 1997 | 2000 | 2004 | 2006 | 2009 |
| *Smoking Status* | | | | | | | |
| Current smoker | 70.0 | 66.2 | 61.7 | 61.3 | 59.0 | 56.5 | 57.1 |
| Former smoker | 3.5 | 5.5 | 5.8 | 7.7 | 6.2 | 7.1 | 5.9 |
| Lifetime non-smoker | 26.5 | 28.3 | 32.5 | 30.9 | 34.8 | 36.4 | 37.0 |
| *Age* | 40.2 | 40.9 | 40.5 | 42.9 | 44.9 | 46.2 | 46.7 |
| | (13.4) | (13.4) | (13.4) | (13.0) | (12.6) | (12.3) | (12.7) |
| *Residence* | | | | | | | |
| Urban | 49.4 | 47.3 | 47.3 | 48.9 | 48.1 | 49.1 | 49.3 |
| Rural | 50.6 | 52.7 | 52.7 | 51.1 | 51.9 | 50.9 | 50.7 |
| *Education* | | | | | | | |
| ≥9 years of schooling | 44.5 | 44.5 | 54.3 | 57.9 | 61.0 | 63.1 | 67.3 |
| <9 years of schooling | 55.5 | 55.5 | 45.7 | 42.1 | 39.1 | 36.9 | 32.7 |
| *Region* | | | | | | | |
| East | 36.3 | 35.4 | 24.0 | 33.9 | 31.6 | 32.7 | 32.8 |
| Middle | 36.0 | 36.4 | 48.3 | 43.3 | 44.3 | 43.9 | 43.8 |
| West | 27.7 | 28.3 | 27.8 | 22.8 | 24.1 | 23.5 | 23.5 |
| *N* | 3,724 | 3,549 | 4,637 | 4,130 | 4,195 | 4,084 | 4,227 |

*Source*: China Health and Nutrition Survey (1991, 1993, 1997, 2000, 2004, 2006, and 2009)
*Note*: Percentages as shown for categorical variables. Means and standard deviations (in parentheses) are shown for continuous variables.