

# Population-Based Survey of Secondhand Smoke Exposure in China<sup>1</sup>

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**Objective** To determine the extent of secondhand smoke exposure in China, and to explore the potential associated factors. **Methods** This study was a nationally representative household survey examining secondhand smoke exposure of non-institutionalized men and women aged 15 and older using a global standardized geographically clustered sample design. A total of 13 354 people completed the individual questionnaire with questions on gender, age, educational level, residence, profession, potential factors associated with secondhand smoke exposure, and workplace smoking policy. The data were used to determine whole population estimates of secondhand smoke exposure. **Results** Among non-smokers aged 15 years and older, it was estimated that 72.4% (556 million) were exposed to secondhand smoke, with 52.5% (292 million) exposed to secondhand smoke daily. The prevalence of secondhand smoke exposure was 74.1% for men, 71.6% for women, 70.5% for urban populations, and 74.2% for rural populations. The rates were 67.3%, 63.3%, and 72.7% respectively, within the household, indoor workplaces and public places. Secondhand smoke exposure was significantly reduced in workplaces with a smoking ban but not in workplaces with a partial smoking ban. **Conclusion** Although China has made some progress toward a smoke-free environment there remains a high degree of exposure to secondhand smoke.

**Key words:** Secondhand smoke; China; Workplace

## INTRODUCTION

There is much scientific evidence that exposure to tobacco smoke causes death, disease and disability, and there is no so-called “safe exposure limit” for passive smoking<sup>[1-3]</sup>. Therefore, Article 8 of the World Health Organization Framework Convention on Tobacco Control (FCTC) has made it clear that each party to the FCTC shall, within their jurisdiction, actively promote, adopt and implement effective legislative, executive, administrative and/or other measures, to protect against exposure to tobacco smoke in indoor workplaces, public transportation, indoor public places and, as appropriate, other public places. Voluntary smoke-free policies have repeatedly proven ineffective. There must be legislative measures to prevent the public from being exposed to tobacco smoke and protect the fundamental individual rights. All parties to the FCTC are required to provide universal protection for the public within 5 years of the FCTC coming into force<sup>[4-5]</sup>.

Although the health hazards of secondhand smoke are known, unfortunately there remains approximately one-third of the world’s population

frequently exposed to secondhand smoke, and it is estimated that 600 000 people die each year worldwide from inhalation of secondhand tobacco smoke<sup>[6]</sup>. Previous surveys conducted in China reported that more than half of non-smokers aged 15 and older had at least 15 minutes or more secondhand smoke exposure at least one day a week. Compared with 1996, no significant change in exposure rate had occurred in 2002, and there was a wide range of locations where there was exposure to secondhand smoke<sup>[7-8]</sup>.

Since the FCTC came into force in January 2006, the Chinese government has taken action to actively promote the introduction of a smoke-free environment in hospitals, schools, public transportation and other public places<sup>[9-11]</sup>. Some tobacco control programs, such as “Towards a Smoke-free China” and “Smoke-free Olympics”, also promoted a smoke-free environment and achieved some positive results in the cities where the projects were implemented. Beijing, Hangzhou, Guangzhou and Yinchuan have introduced local regulations to ban smoking in public places. However, the effect of promoting a smoke-free environment throughout the

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country and the level of secondhand smoke exposure in the general population is in urgent need of evaluation. This study carried out a survey to determine the prevalence of exposure to secondhand smoke among China's population aged 15 and older, the main locations of exposure, and the potential factors associated with secondhand smoke exposure.

## METHODS

The 2010 Global Adults Tobacco Survey-China (GATS CHINA) was developed using a global standardized methodology. The questionnaire included information on respondents' background and demographic characteristics, tobacco use, smoking cessation, secondhand smoke exposure, income, and knowledge, attitudes, and perceptions regarding smoking. Additional details are provided in the GATS CHINA report, which can be found at <http://www.notc.org.cn>.

### *Participants*

The target population for the survey was defined as all Chinese residents, aged 15 years and older, living in their primary residence prior to and including the survey date, excluding those living in student dormitories, military barracks, prisons, or hospitals.

### *Sampling Design*

A multi-stage stratified cluster sampling design was implemented in the survey. The country was divided into six regions: North, Northeast, East, Central and South, Southwest, and Northwest. Each of the six regions was further divided into urban and rural areas, making 12 strata in total. In the first stage, urban districts or rural counties/county-level cities were selected, using the probability proportionate to size (PPS) sampling method from the 2007 household registration database administered by the Ministry of Public Security of China. The measure of size was the number of households. In the second stage, two urban neighborhood communities or rural villages were selected from each of the selected primary sampling units using the PPS method. The selected secondary sampling unit was partitioned into segments of around 1 000 households (using mapping and listing to determine the number) and one segment was randomly selected. In the third stage, 75 households were selected using simple random sampling from each selected segment. Finally, one individual was randomly selected from each participating household using simple random sampling.

### *Data Collection*

GATS CHINA was conducted in 28 of 32 provinces in China. All the survey interviewers and supervisors were trained by Chinese Center for Disease Control and Prevention (China CDC) staff in eight full survey implementation training sessions. The training sessions took place in small groups and were given by the same trainers to ensure consistent quality.

Before interview, mapping and listing was conducted by local CDC staff to identify each selected household. Face-to-face interviews were employed in this survey followed a strict protocol. For young respondents aged 15-17, parental or guardian consent was required. Selected respondents were excluded if the interviewers determined that they were less than 15 years of age and/or were incapacitated. Survey information was collected using a handheld device. Up to four visits to a household were made to interview the target person(s) within that household. A total of 13 354 interviews were completed. In total, the household response rate was 97.5%, the response rate for individuals was 98.5% and the overall response rate was 96.0%.

### *Measures*

*Secondhand smoke exposure among nonsmokers*  
This paper analyzed mainly secondhand smoke exposure among different nonsmoking groups according to gender, age, educational level, residence and profession. The question "In a typical week, how many days are you exposed to smoking?" was used to evaluate the level of non-smokers' exposure to secondhand smoke in the survey. A total of five options were available for this question, namely: almost every day = 1, 4-6 days a week on average = 2, 1-3 days a week on average = 3, none = 4, Refuse to answer = 5. Selection of 1, 2 or 3 was defined as the respondent experiencing secondhand smoke exposure.

*Location of secondhand smoke exposure*  
In this study, secondhand smoke exposure at home was identified if a respondent reported anyone smoking inside his or her household at least once per month. The question "Did anyone smoke inside your workplace during the past 30 days?" was used to estimate secondhand smoke exposure in workplaces. To measure secondhand smoke at public places, respondents was asked if someone smoked in the public places that they had visited during the past 30 days, such as restaurants, public transportation, hospitals, schools, and government buildings.

In addition, all the participants reported whether smoking was allowed in their homes, and those

working indoors were asked about any anti-smoking policy and its enforcement in their workplace.

*Factors associated with secondhand smoke exposure* To explore potential factors associated with secondhand smoke exposure, the following independent variables were investigated: exposure to secondhand smoke (exposed = 1; not exposed = 0) among non-smokers as dependent variables; gender (male = 1; female = 2); age (15-24 years = 1; 25-44 years = 2; 45-64 years = 3; 65 years and above = 4); educational level (primary school or less = 1; attended secondary school = 2; high school graduate = 3; college graduate or above = 4); rural or urban domicile (urban = 1; rural = 2); region (East = 1; Middle = 2; West = 3); awareness of the risk of secondhand smoke (knowing that passive smoking can cause heart diseases in adults, lung diseases in children, and lung cancer in adults = 1, do not know = 2); smoking permitted at home (allowed = 1; generally allowed with occasional exceptions = 2; allowed = 3); anti-smoking regulations in indoor workplaces (smoking allowed in any indoor workplace = 1; smoking only allowed in some indoor areas = 2; smoking prohibited in all indoor areas = 3).

#### *Statistical Analysis*

SUDAAN 10.0.1 was used to compute the estimates and proper standard errors of population parameters. SPSS 18.0 was used for sample weighting and data quality assurance. Each responding unit was assigned a unique survey weight to be used in the calculation of population estimates. The weighting process for GATS China included three main steps: 1) the base weight or design weight, calculated from all steps of random selection in the sample design; 2) an adjustment for non-response by sample households and sample individuals eligible for the survey; and 3) a post-stratification calibration adjustment of sample totals to project to the population aged 15 years and older by region, residence, gender and age.

The final weight assigned to each respondent was computed as the product of the base weight, the non-response adjustment and post-stratification calibration adjustment. The final weight was used in all analyses to produce estimates of whole population parameters. All computations were performed using the SAS 9.1 complex survey data analysis procedure.

## RESULTS

### *Sample and Population Characteristics*

The questionnaire was completed by 13 354 individuals, who were representative of a population of 1 068 752 000 men and women aged 15 years and older in China. The household and the individual

response rates were 97.5% and 98.5%, respectively, and the total response rate was 96.0%.

Respondents comprised 6 603 men and 6 751 women representing a target population of 50.9% men and 49.1% women. By residence, 5 832 and 7 522 individuals were from urban and rural areas, respectively, representing the population of 46.1% in urban areas and 53.9% in rural areas. Regarding education level, 36.4% had attended secondary school, 33.3% had attended primary school or less, 18.8% were high school graduates, and 11.6% were college graduates or above. Occupation was based on definitions by National Bureau of Statistics. 31.6% were agricultural workers, 15.7% were business or service employees, 10.8% were machine operators, 11.0% were unemployed and 9.6% were retired. Only 1.7% surveyed were medical/health personnel, and 1.6% were teaching staff. Overall, there were 71.9% non-smokers, a total of 768 051 000 subjects including 256 353 000 men and 511 698 000 women.

### *Prevalence of Secondhand Smoke Exposure in Non-smokers*

Among all non-smokers aged 15 years and older, the survey projected that 72.4% (556 million) of the population were exposed to secondhand smoke, and 52.5% (292 million) were exposed to secondhand smoke daily. The rate of secondhand smoke exposure were 74.1% (95% confidence interval (CI): 69.6%-78.1%) and 71.6% (95% CI: 68.5%-74.6%) in men and women, respectively, and 70.5% (95% CI: 67.0%-73.7%) and 74.2% (95% CI: 68.8%-79.0%) in urban and rural populations, respectively. The frequency of almost daily exposure to secondhand smoke among women was higher than that among men in both urban and rural areas, and was more marked among rural women (Table 1).

Second-hand smoke exposure varied among different occupational groups. Groups with an exposure rate higher than 80% were: business or service employees (83.1%), leaders of organizations (85.8%), clerks (82.2%); groups with a rate of 70%-80% were: agriculture workers (74.7%), machine operators (77.1%), specialized technicians (79.2%), medical/health personnel (77.1%), teaching staff (70.9%); groups with a rate under 70% were: students (65.2%), the unemployed (64.8%), the retired (53.9%). In addition, nearly half of business or service employees (48.6%) reported exposure to secondhand smoke on an almost daily basis.

Apart from those older than 65 years, whose exposure rate was slightly lower (54.5%), secondhand smoke exposure rates for the other age groups were all greater than 60%. Almost 70% of young people aged 15-24 years were exposed to secondhand smoke (Figs. 1-2).



TABLE 1

Secondhand Smoke Exposure in one Week among Non-smokers Aged 15 and Older – 2010 Global Adults Tobacco Survey-China

	Almost Every Day		4-6 Days Every Week on Average		1-3 Days Every Week on Average		Total	
	Exposure Rate (%)	95% CI	Exposure Rate (%)	95% CI	Exposure Rate (%)	95% CI	Exposure Rate (%)	95% CI
Urban								
Male	33.6	28.9-38.7	5.8	4.2-7.9	34.7	30.4-39.3	74.1	69.7-78.0
Female	38.7	35.2-42.3	4.8	3.4-6.7	25.1	22.3-28.1	68.5	65.1-71.7
Rural								
Male	31.9	25.4-39.3	6.1	4.5-8.1	36.0	30.3-42.2	74.0	66.0-80.7
Female	42.4	37.6-47.3	7.5	5.7-9.9	24.4	20.5-28.9	74.3	69.3-78.8
Total	38.0	34.8-41.3	6.1	5.1-7.4	28.3	25.4-31.4	72.4	69.2-75.5

Note. CI: confidence interval.

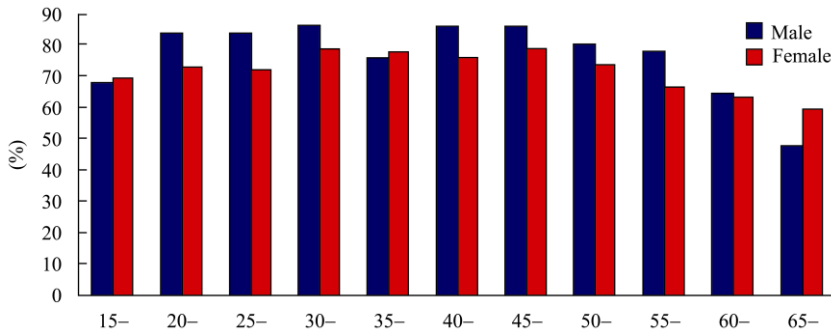


FIG. 1. Prevalence of secondhand smoke by gender, China 2010.

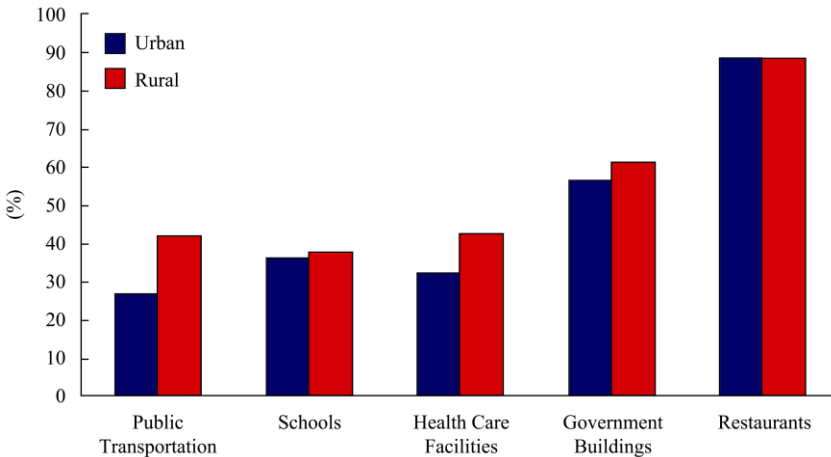


FIG. 2. Percentage of adults  $\geq 15$  years old who noticed smoking at various public places, by residence, China 2010.

### Locations of Secondhand Smoke Exposure

#### Household

In the survey, 67.3% (95% CI: 64.1%-70.2%) of all respondents reported there was someone in their own home who smoked. The rate was 63.9% (95% CI: 60.6%-67.0%) for women and 70.5% (95% CI: 67.0%-73.9%) for men. In rural areas, 73.4% of respondents (95% CI: 68.5%-77.8%) reported that smoking occurred in their own homes, which is higher than the rate in urban cities of 60.0% (95% CI:

56.4%-63.5%). The rate of secondhand smoke exposure was highest for subjects with primary and secondary school education (68.9% and 71.5%, respectively), followed by high school graduates (62.5%), while graduates of college or above had the lowest rate (51.7%).

#### Indoor Workplaces

The rate of indoor workplace smoke exposure was 63.3% (95% CI: 59.2%-67.2%), 71.1% for males

(95% CI: 66.3%-75.4%), which was higher than the rate of 53.2% for females (95% CI: 47.7%-58.6%).

Although hospitals and schools had the lowest rate, over half of the respondents still reported someone smoking in their workplace (55.4% of health care professionals and 54.8% of teachers). The rates for agricultural workers, leaders of organizations and business or service employees were higher at their workplaces (78.5%, 73.2%, and 71.8%, respectively).

There was no significant difference in the rates of exposure in indoor workplaces according to educational level: college graduate or above: 64.4%; high school graduate: 68.0%; secondary school education: 72.2%; primary school education or less: 72.3%.

#### *Public places*

Public places currently are the worst among all places for exposure to secondhand smoke in China (as shown in Fig. 2), and 72.7% (95% CI: 69.4%-75.8%) of respondents reported exposure to smoking in public places, 81.1% for males (95% CI: 78.2%-83.7%), higher than for females (63.3%; 95% CI: 58.9%-67.5%). Among public places, the rate in restaurants was the highest at 88.5%, followed by 58.4% for government offices, 37.9% for health care institutions, 36.9% for schools, and 34.1% for public transportation. Thus, restaurants and government buildings are the main places of secondhand smoke exposure. However, hospitals, schools and public transportation have yet to become 100% smoke-free.

The smoking environment in schools and restaurants in urban and rural areas were similar, however, in government buildings, medical institutions and public transportation, the rate was higher in rural than in urban areas, and was greatest in public transportation.

#### *Factors Associated with Secondhand Smoke Exposure*

Multivariate analysis found that rate of population exposure to secondhand smoke among Chinese males was higher than that for females (odds ratio (OR): 0.779, 95% CI: 0.640-0.948), and there was no significant difference between rural and urban areas (OR: 0.971, 95% CI: 0.738-1.278). There were only slight differences between age groups, with the exposure rate for the 25-44 age group the highest; there was no significant difference between the 15-24 age group (72.2%) and the 45-64 age group (72.1%), whose rates were slightly lower than in the 25-44 age group (77.7%); the rate for the over 65 age group was the lowest (54.5%). Secondhand smoke exposure in households where smoking was prohibited was markedly less than in those that allowed smoking (OR: 0.242, 95% CI: 0.171-0.343), in households where

smoking was not allowed but with occasional exceptions there was lower secondhand smoke exposure than in those that allowed smoking (OR: 0.710, 95% CI: 0.546-0.924); indoor workplaces with a comprehensive smoking ban had much lower secondhand smoke exposure than those without such a policy (OR: 0.319, 95% CI: 0.227-0.448), but there was no significant difference between those with a partial smoking ban and those without a ban (OR: 0.924, 95% CI: 0.614-1.390) (Table 2).

## DISCUSSION

From the results of this survey, it can be extrapolated that 556 million (72.4%) non-smokers aged 15 years and older in China are exposed to secondhand smoke, and 292 million are exposed to secondhand smoke on a daily basis. Smoking was reported to occur in the homes of 67.3% of respondents; 63.3% of people who worked indoors were exposed to smoking in their workplace; in the 30 days preceding the survey, the rate of secondhand smoking was as high as 72.7% in government buildings, medical facilities, restaurants, public transportation or schools, indicating that the situation of exposure to secondhand smoke in China in 2010 remains very serious, and there is a significant gap between China's progress in creation of a smoke-free environment and the requirements of Article 8 of the FCTC guidelines. A 100% smoke-free macro social environment that can effectively protect people from the hazards of secondhand smoke is still at a rudimentary stage.

Smoking among Chinese women is at a much lower level (2.4%) compared with men (52.9%), but over 70% of women are exposed to tobacco smoke. The impact of tobacco on women's health requires urgent attention.

Hospitals and schools have been the key locations for creation of a smoke-free environment in China in recent years. The Chinese government issued a "Decision on a Nationwide Comprehensive Smoking Ban in Medical Institutions since 2011"<sup>[9]</sup> and "Opinions on Further Strengthening Tobacco Control in Schools"<sup>[10]</sup>, introduced standards for smoke-free hospitals and schools, required all medical and health institutions to be fully smoke-free by the end of 2011, with a program for smoke-free schools too. A large number of tobacco control programs have contributed numerous efforts in creating smoke-free hospitals and schools. However, this survey showed that in China, there remained 55.4% of medical/health personnel and 54.8% of teaching staff exposed to smoke in their workplaces. It is thus clear that tobacco control in China is a truly major task.

TABLE 2  
Individual-level Factors Associated with Prevalence of Secondhand Smoke

Variables	Prevalence of Secondhand Smoke (%)		Multivariate Analysis	
	Rate	95% CI	OR	95% CI
<b>Gender</b>				
Male=1	74.1	(69.6-78.1)		Reference
Female=2	71.6	(68.5-74.6)	0.779	0.640-0.948
<b>Age</b>				
15-24	72.2	(65.6-77.9)		Reference
25-44	77.7	(74.7-80.5)	1.336	1.068-1.672
45-64	72.1	(68.3-75.7)	0.976	0.755-1.262
≥65	54.5	(50.1-58.7)	0.456	0.348-0.598
<b>Residence</b>				
Urban	70.5	(67.0-73.7)		Reference
Rural	74.2	(68.8-79.0)	0.971	0.738-1.278
<b>Education</b>				
Primary School or Less	69.7	(65.0-74.1)		Reference
Attended Secondary School	73.9	(69.4-77.9)	1.030	0.811-1.310
High School Graduate	72.7	(68.1-76.8)	1.150	0.893-1.482
College Graduate or Above	74.1	(68.7-78.9)	1.314	0.924-1.868
<b>Awareness of Health Hazards Posed by Secondhand Smoke</b>				
Yes	69.6	(64.5-74.2)		Reference
No	73.5	(70.0-76.6)	1.187	0.946-1.489
<b>Region</b>				
East	68.3	(63.9-72.3)		Reference
Central	75.3	(70.2-79.7)	1.357	0.964-1.910
West	75.2	(67.7-81.4)	1.403	0.942-2.089
<b>Rules about Smoking inside Your Home</b>				
Allowed	77.0	(73.7-79.9)		Reference
Not Allowed, but Exception	71.5	(66.6-75.9)	0.710	0.546-0.924
Never Allowed	46.0	(38.5-53.7)	0.242	0.171-0.343
<b>Indoor Smoking Policy in the Workplace*</b>				
Allowed everywhere	86.0	(81.3-89.7)		Reference
Allowed Only in some Indoor Areas	82.7	(76.8-87.4)	0.924	0.614-1.390
Not Allowed in Any Indoor Areas	63.6	(57.1-69.8)	0.319	0.227-0.448

Note. OR: odds ratio; \*Refers to nonsmoker working indoors.

In 1996, the secondhand prevalence model in China found that exposure was higher in urban than rural areas, and exposure among women was higher than men<sup>[7]</sup>; in 2002, the exposure among women was still higher than among men, but that in rural areas became higher than urban areas<sup>[8]</sup>; the current survey found no significant difference in the exposure to secondhand smoke between the urban and rural Chinese population, but the rate was higher among men than women. Additionally, the survey results of 1996 and 2002 showed that secondhand smoke exposure mainly occurred in households (71.2% in 1996 and 82.0% in 2002), and the rate of exposure in public places and workplaces was relatively low (32.5% in public places and 25.0% in workplaces in 1996; 67.0% in public places and 35.0% in workplaces in 2002<sup>[7-8]</sup>). However, the current survey found that public places had become the worst

places for secondhand smoke exposure (72.7%), followed by households (67.3%) and workplaces (63.3%). These results indicated that the pattern of secondhand smoke exposure is changing in China.

In the 1996 and 2002 surveys, the definition of secondhand smoke exposure was "at the time of the survey, the nonsmoker was exposed to tobacco smoke for a minimum of 15 minutes at least one day a week."<sup>[7-8]</sup> Compared with the rates determined using the definition in the current survey, the rate of secondhand exposure in the previous surveys was relatively low. However, the rate of secondhand exposure in households in the 2010 survey was lower than that in 2002<sup>[8]</sup>, thus we can conclude that the percentage of secondhand smoke exposure among Chinese population in households has dropped since 2002. This indicates that before the external environment becomes smoke-free, people have begun

spontaneously creating smoke-free households, and awareness of the need to protect themselves from the hazards of secondhand smoke is increasing.

The results of this research indicates that prohibiting smoking in households and completely banning smoking in indoor workplaces can fully protect people from the hazards of secondhand smoke. Other studies also proved that a smoke-free indoor environment was effective and easy to implement for the prevention of exposure to secondhand smoking, and a 100% ban on smoking in any kind of indoor environment is the only intervention that can effectively protect people from the hazards of secondhand smoke<sup>[12-13]</sup>. Hence, the authors believe that the Chinese government needs to accelerate its pace of tobacco control, effectively implement existing laws and regulations, enact smoke-free legislation in public places nationwide, promote a wide range of public educational activities, and advocate smoke-free households to protect people from the hazards of secondhand smoking.

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