

# **The effects of workplace smoke-free policies on individual smoking and quitting-related behaviours in China: evidence from repeated cross-sectional survey data**

Hao-xiang LIN<sup>1</sup>, Chun CHANG<sup>1</sup> Zhao LIU<sup>2</sup>,

<sup>1</sup>Department of Social Medicine and Health Education, School of Public Health, Peking University Health Science Center, Beijing, China

<sup>2</sup>Tobacco Medicine and Tobacco Cessation Center, China-Japan Friendship Hospital, Beijing, China

**Correspondence to** Chun CHANG and Zhao LIU

**Chun CHANG and Zhao LIU should be considered as co-corresponding authors**

## **What this paper adds:**

- This study joins the debate in recent years on the effects of workplace SF policies and provides more comprehensive evidence by repeated cross-sectional data.
- Most companies had established workplace SF policies; however, the overall prevalence of SHS exposure remains very high (52.5%).
- Workplace SF policies showed a strong association with lower SHS exposure, lower smoking prevalence and higher harm awareness of smoking; however, the association with smokers' quitting intentions was weak.

**Word count:** abstract 215 words, text 2926 words

**5 Tables**

## **ABSTRACT**

**Objective** Our study aims to determine the coverage of workplace Smoke-free (SF) policies in mainland China, and to assess the relationship between workplace SF policies and Second-hand smoke (SHS) exposure, smoking prevalence, smoking harm awareness, and quitting intention among smokers.

**Methods** The Logistic regression with year fixed effects is applied to the Asia Best Workplace Mainland China study, a repeated cross-sectional dataset including approximately 14,195 employees from the 2018 survey and 14,953 employees from the 2019 survey.

**Results** 21,275 participants (73.0%) reported working under SF policies. The overall prevalence of smoking and SHS exposure were 20.3% and 52.5%. The workplace SF policy was significantly associated with lower SHS exposure (OR: 0.501, 95% CI: 0.473-0.530), lower smoking prevalence (OR: 0.813, 95% CI: 0.761-0.869) and higher awareness of smoking harm (OR: 1.756, 95% CI: 1.612-1.913). However, workplace SF policy was not significantly associated with quitting intention (OR: 0.984, 95% CI: 0.837-1.158).

**Conclusion** Our study identified that although most companies have established workplace SF policy, the overall prevalence of SHS exposure remains very high. The findings supports the existence of spill-over effects of SF workplace policies. Regarding to triggering strong quitting intentions, the SF policies should consider provided in combination with available smoking cessation services. These findings provide valuable evidence to promote such policies in all workplaces.

**KEY WORDS** Smoke-free policy, Workplace, Second-hand smoke exposure;

## Introduction

Because second-hand smoke (SHS) contains hundreds of chemicals known to be toxic and carcinogenic, involuntary SHS exposure contributes to premature death and causes a number of diseases in non-smokers<sup>[1-2]</sup>. The workplace is a major source of SHS exposure for adults, and the negative influence incurred by SHS exposure affects workplace productivity and contributes to absenteeism<sup>[3]</sup>.

Smoke-free (SF) policy has been a key contributor to the decline in SHS exposure. As of July 2019, 25 US states had adopted comprehensive 100% SF laws in workplaces, restaurants and bars, leading to a sharp decrease in SHS exposure from 52.5% during 1999–2000 to 25.2% during 2013–2014<sup>[4]</sup>. Since China ratified the Framework Convention on Tobacco Control (FCTC)<sup>[5]</sup> in 2005, considerable progress has been made to reduce SHS exposure in China, particularly implementing SF policies. As a result, according to the Chinese Adult Tobacco Survey, the prevalence of SHS exposure was 63.3% in 2010<sup>[6]</sup>, 54.3% in 2015<sup>[7]</sup>, and 50.9% in 2018<sup>[8]</sup>.

Despite the processes, China currently does not have a national legislation for workplace SF policy<sup>[9]</sup>, and the implementation of workplace SF policies and its impact has not been fully investigated. Most studies examining the association between workplace SF policy and SHS exposure have been conducted in western countries<sup>[10-11]</sup>. One study in 2010 reported that workplace SF policy had significant associations with lower smoking prevalence and daily cigarette consumption but not with employee quitting intentions; however, this study only collected 1070 questionnaires from one company in Shanghai<sup>[12]</sup>. Another study reported that workplace SHS exposure was associated with respiratory symptoms in Shanghai<sup>[13]</sup>. To the best of our knowledge, no more recent study has been conducted on this topic. Such knowledge is critically needed as it can help inform policymakers and health practitioners to establish stronger SF policy and conduct campaigns and interventions to reduce exposure to workplace SHS in China.

To help fill the evidence gap, we reported the findings from a repeated cross-sectional survey in the form of two years of datasets, with the goal of providing valuable evidence to promote such policies. Specifically, we aimed to (1) determine the coverage of workplace SF policies in mainland China, and (2) to assess the relationship between workplace SF policies and SHS exposure, smoking prevalence, smoking harm awareness (SHA), and quitting intention (QI) among smokers.

In addition, this paper extends prior research along two dimensions. First, it extends to participants living in the entire mainland of China, rather than a city or province. Although our sample is not nationally representative, we believe it can provide more valuable information than can a local sample. Second, we use repeated cross-sectional data taken in 2018 and 2019, rather than a single dataset. By using survey data in different years, this paper considers the possible systematic differences between years: using fixed effects to control for year-specific characteristics.

## **Methods**

### **Study design and participants**

The Asia Best Workplace Mainland China( ABWMC )programme was a repeated cross-sectional survey that aimed to support companies in building healthy workplaces through policy, infrastructure, and culture. The ABWMC programme was designed by Peking University and was organised by the American International Assurance Co. who invited companies to join the programme using a convenience sampling method. The inclusion criteria for participating companies were as follows: (1) legal companies registered in China; (2) at least 100 full-time employees; and (3) agreement to participate in the programme. The inclusion criteria for participating employees were as follows: (1) age 18 years old or above; (2) full-time employment; and (3) agreement to participate in the programme.

A four-stage method was applied in this survey. At the first stage, experts of Peking University designed the standardised questionnaires, including demographic and sociological information, payment and welfare information, individual health literacy and lifestyle information, smoking-related behaviour and quitting intentions, etc. At the second stage, an online survey system was developed by Ipsos Inc., and a specific Internet link was generated. The self-check function of the online survey system automatically identified missing data, logical errors and illegal characters. At the third stage, the Human Resources Departments of each joined company delivered the Internet link to all the employees. After signing informed consent online, employees completed and submitted the questionnaire. All participants knew the statistical analyses would be conducted anonymously and that their information would be used for research purposes and published. At the final stage, the submitted questionnaires were reviewed by the staff at Peking University and the respondents were contacted for clarifications if any problems were detected. This study was approved by

Peking University (number: IRB00001052-18055).

We used the 2018 and 2019 ABWMC programme data. The total sample size was 29,148 in which there were 14,195 from the 2018 survey and 14,953 from the 2019 survey.

## **Measurements**

### **SHS exposure and workplace SF policies**

The presence of SHS exposure was measured using the question ‘How many days per week do you usually suffer from SHS exposure at the workplace for more than 15 minutes a day? A: almost every day; B: 4-6 days; C: 1-3 days; D: never’. Respondents who answered D were considered to be working without SHS exposure. The presence of a workplace SF policy was measured using the question ‘Does your company have SF policies? A: no SF policies; B: SF policies that permit smoking in parts of the indoor area; C: SF policies that completely ban smoking inside the building; D: I have no idea’. Respondents who answered C were considered as working under an SF policy.

### **Smoking and quitting intentions**

Smoking was measured by the following question: ‘Do you smoke now? A: yes, every day, B: yes, only occasionally, C: I have quit smoking, D: never’. Respondents who answered A or B were considered to be current smokers. Quitting intentions were measured using the question ‘Are you going to quit smoking? A: yes, within a month, B: yes, within 6 months, C: yes, but not within 6 months, D: no plan for quitting’. Respondents who answered A or B or C were considered as intending to quit.

### **Smoking harm awareness**

Smoking harm awareness was measured by the following question ‘To the best of your knowledge, which diseases can be caused by smoking? A: stroke, B: heart disease, C: lung cancer, D: cardiovascular disease, E: chronic obstructive pulmonary disease, F: asthma, G: I don’t know.’ Respondents who chose all the answers from A to F were considered to have smoking harm awareness.

### **Other control variables**

In addition to these key variables, other variables such as sex, age, marital status, ethnicity, education,

chronic diseases, job position, and night-shift duty were collected as control variables.

## Data analysis

Logistic regression was used to estimate the effects of workplace SF policies on individual smoking and quitting behaviours. The specification of our empirical model was as follows:

$$\text{SHS exposure (or smoking)} = \beta_0 + \beta_1 \text{ SF policy} + \gamma X_i + \gamma_t + \varepsilon_{it}.$$

The dependent variable was either SHS exposure or smoking. The explanatory variable SF policy was a dummy indicating whether an employee was working for a company that had an SF workplace policy or not (if yes=1; otherwise=0).  $\gamma X_i$  is a variety of other control variables,  $\gamma_t$  is the year fixed effects to control for year-specific factors, and  $\varepsilon_{it}$  is the error term. We also perform regression with each year's sample separately.

To determine whether such policy had effects on smoking harm awareness and quitting intention, we changed the dependent variable and ran the following regression:

$$\text{SHA (or QI)} = \beta_0 + \beta_1 \text{ SF policy} + \gamma X_i + \gamma_t + \varepsilon_{it}.$$

Our analyses used all participants for whom the variables of interest were available, with no imputation for missing data. All statistical analyses were performed using SPSS 19.0.

## Role of the funding source

The funders of the study had no role in the design of the study; collection, analysis, or interpretation of the data; or the writing of the paper.

## Result

A total of 79 companies participated in the 2018 ABWMC programme. Of them, 53.2% were private Chinese companies, 32.9% were foreign companies, 7.6% were state-owned companies, and 6.3% were joint ventures; 39.2% of the companies were located in Shanghai, 26.6% in Guangdong Province, 20.3% in Beijing, 11.4% in Jiangsu Province and 2.5% in Sichuan Province; 84.8% of the companies implemented a workplace SF policy.

Another 85 companies participated in the 2019 programme. Of them, 43.5% were foreign companies, 42.4%

were private Chinese companies, 11.8% were joint ventures, and 2.4% were state-owned companies; 52.9% were located in Shanghai, 14.1% in Jiangsu Province, 11.8% in Guangdong Province, 10.6% in the city of Beijing, 3.5% in the city of Shenzhen, and 7.1% in other cities; 94.1% of the companies have implemented a workplace SF policy.

In all the companies, 29,148 individuals participated in this study and submitted the questionnaires. The characteristics of the participants are shown in **Table 1**. The overall prevalence of smoking and SHS exposure were 20.3% and 52.5%, respectively; 46.7% of the study population was male, with the average age of  $31.78 \pm 7.11$  years; the majority of participants were married (59.9%) and held bachelor's degrees or above (86.1%); 21,275 participants (73.0%) reported working under SF policies. Unfortunately, only 15.0% of participants had comprehensive awareness of smoking harms.

As shown in **Tables 2-5**, after adjusting for, age, education, marriage, etc., and controlling for year fixed effect, the workplace SF policy was significantly associated with lower SHS exposure (OR: 0.501, 95% CI: 0.473-0.530), lower smoking prevalence (OR: 0.813, 95% CI: 0.761-0.869) and higher awareness of smoking harm (OR: 1.756, 95% CI: 1.612-1.913). However, workplace SF policy was not significantly associated with quitting intention (OR: 0.984, 95% CI: 0.837-1.158).

## **Discussion**

To the best of our knowledge, our study was one of the largest surveys to date to evaluate the impacts of workplace SF policies on SHS exposure and smoking-related behaviour in a Chinese population. The results showed the following: (1) most companies had established workplace SF policies; however, the overall prevalence of SHS exposure remains very high (52.5%); (2) workplace SF policies showed a strong association with lower SHS exposure, lower smoking prevalence and higher harm awareness of smoking; and (3) the association with smokers' quitting intentions was weak.

Article 8 of the WHO FCTC requires parties to adopt and implement measures to reduce exposure to tobacco smoke in indoor workplaces, indoor public places, public transport and other public places <sup>[5]</sup>. Since the FCTC was ratified in 2005, the Chinese government has made a serious commitment to reduce or eliminate SHS exposure in workplaces; the prevalence of SHS exposure was reduced from 63.3% in 2010 <sup>[6]</sup> to 50.9% in 2018 <sup>[8]</sup>, which was similar to the 54.7% found in our study. Moreover, our study found a strong

correlation between workplace SF policies and lower SHS exposure, which was consistent with a systematic review suggesting that SHS exposure in the workplace decreased significantly from 20% to 8% after an SF policy was implemented <sup>[14]</sup>.

As an impressive finding, our data suggested that the influence of workplace SF policies was not limited to a reduction in SHS exposure. Therefore, reducing SHS exposure is not simply the result of the implementation of workplace SF policies. Rather, the change may reflect a synergism of multiple factors, with such forces working in conjunction to contribute to lowering SHS exposure. Our findings reinforce the recommendations of a previous study that SF policies may lead to spreading of smoke-free norms in the workplace <sup>[15]</sup>. Furthermore, our study actually supports the existence of spill-over effects of SF workplace policies. How do these factors interact with one another? Is there any potential mediator? All these questions merit further research. A detail description of the internal mechanisms and possible pathways will be reported elsewhere <sup>[16]</sup>.

In general, workplace SF policies should motivate smokers to quit by making it more difficult to smoke; for example, smokers must go out of their workplace to smoke and increase the time cost of smoking <sup>[17]</sup>. However, consistent with the findings of a previous study <sup>[11]</sup>, no significant association was found between workplace SF policies and more positive quitting intention. One possible explanation was the ‘hardcore’ smokers who may be less motivated to quit regardless of SF policies at worksites; therefore, more intensive intervention should be provided for them <sup>[18]</sup>. Another explanation was the violation of workplace SF policy. The effects of workplace SF policy would be undermined when it is violated by large numbers of smokers who continue to smoke, and this non-compliance may jeopardise a smoker’s quitting intention because they are surrounded by others who continue to smoke <sup>[19]</sup>.

Our study has several limitations. First, the ABWMC programme was launched in 2018, and we only had two years of repeated cross-sectional data for this estimation. As a result, we cannot infer a causal relationship, which is an inherent characteristic of all cross-sectional studies. Second, workplace SF policy was self-reported without verification, and respondents’ definitions of workplace SF policy may vary. Third, the companies who joined the ABWMC programme were mainly located in developed areas of China; therefore, our data are not a nationally representative sample. Fourth, we only measured SHS exposure in

the workplace, and SHS exposure from elsewhere was neglected. In addition, we did not measure smoking reduction or the duration of workplace SF policies and policy enforcement, including incentives and penalties.

Despite these limitations, our findings have practical policy implications. The results of the present study could encourage policymakers and health practitioners to accelerate the implementation of SF policy and thereby contribute to a broader SF culture in the workplace. In particular, because the effect of current workplace SF policy on quitting intention was weak, the SF policies should be provided in combination with smoking cessation services. As with the results of the ABWMC programme, our findings will be disseminated to the participating companies, which may not only encourage those struggling to catch up but will also encourage them to establish more comprehensive workplace SF policies and further improve health status in China.

## **Conclusion**

Using ABWMC programme data, this study provides a comprehensive picture of the impact of SF workplace policies on possible smoking-related behaviour using Chinese data. It identified that although most companies have established workplace SF policy, the overall prevalence of SHS exposure remains very high. The findings supports the existence of spill-over effects of SF workplace policies. Regarding to triggering strong quitting intentions, the SF policies should consider provided in combination with available smoking cessation services. These findings provide valuable evidence to promote such policies in all workplaces.

## **Abbreviations**

Smoke-free (SF)

Second-hand smoke (SHS)

Framework Convention on Tobacco Control (FCTC)

Smoking harm awareness (SHA), and quitting intention (QI)

Asia Best Workplace Mainland China ( ABWMC )

## **Declarations**

## **Ethics approval and consent to participate**

This study was approved by the Peking University (Ethical approval number: IRB00001052-18055).

Informed consent obtained from online.

## **Consent for publication**

Not applicable

## **Availability of data and material**

The data of the studies is accessible via Peking University, School of Public Health.

## **Competing interests**

We declare no conflicts of interest

## **Funding**

This study was supported by AIA Company limited.

## **Authors' contributions**

HX L and Z L finished the first draft. CC managed the study. All authors have approved the final paper for submission.

## **Acknowledgements**

The authors thank all the participants of the ABWMC programme. The authors also thank LI Tong for her proofreading skills.

## **Reference**

- [1] Oberg M, Jaakkola MS, Woodward A, et al. Worldwide burden of disease from exposure to second-hand smoke: a retrospective analysis of data from 192 countries. *Lancet*, 2011, 377(9760): 139–146.
- [2] Kuehn B. Secondhand Smoke Exposure. *JAMA*, 2019, 321 (4): 336.
- [3] Nishiura C, Narai R, Ohguri T, et al. The Effect of Smoking Prevalence at Worksites on Individual Cessation Behavior. *Journal of Occupational Health*, 2009, 51(1): 48-56.
- [4] Hafez AY, Gonzalez M, Kulik MC, et al. Uneven Access to Smoke-Free Laws and Policies and Its Effect on Health Equity in the United States: 2000-2019. *Am J Public Health*, 2019, 109 (11): 1568-1575.
- [5] World Health Organization. Parties to the WHO Framework Convention on Tobacco Control. [http://www.who.int/fctc/signatories\\_parties/en/index.html](http://www.who.int/fctc/signatories_parties/en/index.html).
- [6] Yang GH, Li Q, Wang CX, et al. Findings from 2010 Global Adult Tobacco Survey: Implementation, of MPOWER Policy in China.
- [7] China Disease Control and Prevention Center. 2015 China Adult Tobacco Survey. Beijing: China CDC, 2016.
- [8] China Disease Control and Prevention Center. 2018 China Adult Tobacco Survey. Beijing: China CDC, 2019.
- [9] Lin H, Chang C, Liu Z, et al. Subnational smoke-free laws in China. *Tobacco Induced Diseases*. 2019, 17: 78.
- [10] Olivia W, Ashleigh G, Laura T, et al. Signs, Fines and Compliance Officers: A Systematic Review of Strategies for Enforcing Smoke-Free Policy. *International Journal of Environmental Research & Public Health*, 2018, 15 (7): 1386.
- [11] Lin H, Wang H, Wu W, et al. The effects of smoke-free legislation on acute myocardial infarction: A systematic review and meta-analysis. *BMC Public Health*, 2013, 13: 529.
- [12] Gao J, Zheng P, Gao J, et al. Workplace smoking policies and their association with male employees smoking behaviours: a cross-sectional survey in one company in China. *Tobacco Control*, 2011, 20(2):131-136.
- [13] Zheng P, Li W, Chapman S, et al. Workplace exposure to secondhand smoke and its association with respiratory symptoms-a cross-sectional study among workers in Shanghai. *Tob Control*, 2011, 20 (1): 58-63.
- [14] Nazar GP, Lee JT, Glantz SA, et al. Association between being employed in a smoke-free workplace and living in a smoke-free home: evidence from 15 low and middle income countries. *Prev Med*, 2014, 59: 47-53.
- [15] Nazar GP, Lee JT, Glantz SA, et al. Association between being employed in a smoke-free workplace and living in a smoke-free home: evidence from 15 low and middle income countries. *Prev Med*, 2014, 59: 47-53.
- [16] Lin HX, Chun Chang, Zhao Liu, The effects of smoke-free workplace policies on individual smoking behaviours in China, *Nicotine & Tobacco Research*, ntaa112, <https://doi.org/10.1093/ntr/ntaa112>

- [17] Smedslund G, Fisher KJ, Boles SM, et al. The effectiveness of workplace smoking cessation programmes: a meta-analysis of recent studies. *Tob Control* 2004, 13: 197-204.
- [18] Leung DY, Chan SS, Chan V, et al. Hardcore smoking after comprehensive smoke-free legislation and health warnings on cigarette packets in Hong Kong. *Public Health*, 2016, 132: 50-56.
- [19] Barnoya J, Monzon JC, Briz P, et al. Compliance to the smoke-free law in Guatemala 5-years after implementation. *BMC Public Health*, 2016, 16: 318.