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Social Science & Medicine 306 (2022) 115159

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Men smoke less under the COVID-19 closure policies: The role of altruism

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ARTICLE INFO

Keywords:
COVID-19
Smoking
Public health policy
Family altruism
Personality

ABSTRACT

This study examines whether people smoked more under the Coronavirus Disease 2019 (COVID-19) closure policies which trapped them at home with their families. In such circumstances, the pleasure from smoking could be more tempting than usual, but at the same time smokers' families are more likely to be victims of passive smoking. This study uses temporal and regional variations in policy strengths with data from the Oxford COVID-19 Government Response Tracker project (OxCGRT) to examine the impact of COVID-19 closure policies on smoking behaviors. With longitudinal data from the China Family Panel Studies (CFPS) in 2018 and 2020, we find diminished smoking behaviors among Chinese male adults when the government implemented strict public health policies for the COVID-19 pandemic. People with more conscientiousness personality traits or stronger pro-family attitudes tend to smoke less as policy stringency increases.

1. Introduction

Adam Smith assumes individuals are selfish in markets but also stresses that it is human nature for people to care deeply about the welfare of their families (Becker, 1981). Scientists have accumulated evidence supporting the power of human altruism over success in economic cooperation and social prosperity (Fehr and Fischbacher, 2003). Family altruism prevails worldwide (Becker and Murphy, 1988), deterring second-hand smoke situations within families (Johnston and Thomas, 2008). Meanwhile, Koo et al. (1988) find that family members are heterogeneously exposed to second-hand smoke. However, some people still behave selfishly regardless of negative externality effects on their families. According to a report by the World Health Organization, second-hand smoke kills about 1.2 million nonsmokers each year, around 15 percent of all deaths from tobacco.[1] Our study focuses on the effects of family altruism on smoking and explores the role of altruism heterogeneity.

The shifts in closure policies exogenously determine how much one's family is exposed to his/her smoking, and thus provides us a chance for causal identification. COVID-19 closure policies impose two opposite forces on smoking behaviors; the policy-triggered anxiety, and the consideration of smoking's negative externalities. On one side, the pleasure from a cigarette becomes more tempting when a man is anxious. On the other, because people spend more time at home under closure policies, if smoking behaviors unchanged, their families are more likely to suffer from passive smoking.

We find that diminished smoking behaviors of Chinese male adults occurred when local governments implemented strict closure policies for COVID-19 in 2020. It suggests family altruism overrides personal anxiety in this case. We further control for respondents' smoking behaviors in 2018 to alleviate the omitted variable problem. The effects are still economically significant: a 10-point increase in the stringency index decreases the prevalence of smoking status by 6 percent and reduces the average number of cigarettes consumed per day by 2.35.

The empirical results also show that men respond to the closures policies differently, which leads us to further investigate the heterogeneity of family altruism. We find that people with more conscientiousness personality traits or having stronger pro-family attitudes tend to smoke less when closure policies become more stringent. Individuals tend to smoke less under closure policies if they live in family structures where the externalities of smoking are more intensive. The results also show that respondents with stronger neuroticism personality traits or more pre-pandemic depressive symptoms tend to smoke more under closure policies, which supports the hypothesis that closure policies trigger anxious moods and then induce higher prevalence of smoking in some groups.

This study contributes to the emerging literature on health behaviors during the COVID-19 pandemic. Some studies find that people smoke more during lockdowns (Gendall et al., 2021; Guignard et al., 2021; Jackson et al., 2022; Reynolds et al., 2021), while others report increases

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[1] https://www.who.int/news-room/fact-sheets/detail/tobacco. Accessed 22 March 2022.

https://doi.org/10.1016/j.socscimed.2022.115159
Received 2 April 2022; Received in revised form 21 May 2022; Accepted 16 June 2022
Available online 22 June 2022

in smoking cessation or more attempts to quit smoking (Carreras et al., 2021; Jackson et al., 2021). This study joins this debate by considering the role of family altruism and providing empirical evidence from China. Some scholars have worried about the potential adverse consequences on the health of smokers' family members during the COVID-19 pandemic (Bar-Zeev et al., 2021; Grundy et al., 2020; Osinibi et al., 2021; Zhang and Liu, 2021). This study argues that some people altered their smoking behaviors to protect their families' health.

This study also enhances our understanding of the relationship between personality traits and health behaviors. Economists have been increasingly interested in how personality traits shape behaviors (Dal Bó et al., 2013; Donato et al., 2017; Proto et al., 2019). The heterogeneity of personality traits leads to different health behaviors, which then causes the divergence in health outcomes. For example, with cross-sectional data, psychologists have shown that smoking is negatively correlated to conscientiousness traits and positively related to neuroticism traits (Malouff et al., 2006; Terracciano and Costa Jr, 2004). However, how personality traits interact with health outcomes in a changing environment is largely unexplored (Friedman, 2000). So far as we know, this work is the first longitudinal study to discuss the role of personality traits in altering smoking behaviors.

This study is also related to the literature on family influence on smoking. Previous studies have examined several family-level factors, such as pregnancy health, adolescent deviance, and family-based smoking cessation interventions (Hill et al., 2005; Hubbard et al., 2016; Johnston and Thomas, 2008). Economists have recently shown the educational spillover effects within a family (Arendt et al., 2021; De Neve and Fink, 2018; Ma, 2019). Using China's compulsory schooling reform in the 1980s as a quasi-experiment, L. Xie et al. (2021) find that adult children's educational attainment encourages parents' smoking cessation. Marriage status and parenthood also correlate to smoking behaviors (Cho et al., 2008; Waldron and Lye, 1989). This study investigates the role of family in smoking cessation in the context of COVID-19 closure policies, under which the exposure to second-hand smoke within the family experiences an exogenous increase.

2. Measures

2.1. Data

This data used in this study is from the fourth and fifth waves of the China Family Panel Study (CFPS, 2018 & 2020). The CFPS project is a biennial longitudinal survey to collect a nationally representative sample of Chinese households (Y. Xie and Hu, 2014). Due to the COVID-19 pandemic and related closure policies, about 88.5% of respondents in CFPS 2020 were surveyed via telephone, and all the adult questionnaires were collected from July to December in 2020. We employ the dataset of CFPS 2018 to control for respondents' pre-pandemic characteristics, especially respondents' smoking behaviors in 2018. Therefore, we only keep respondents who had been surveyed in both CFPS 2018 and CFPS 2020 in the sample.

We further restrict the sample to male adults aged between 18 and 60 due to three considerations. First, in China, the absolute majority of smokers are men. Even though the prevalence of smoking among Chinese men has decreased from about 70% in 1990 to 52% in 2016, only about 2.7% of adult women are currently smokers (Luo and Xie, 2015; World Health Organization, 2019). Second, selling cigarettes to minors is illegal in China and then adolescent smokers are a quite selective sample. For the same reason, we also exclude respondents who are registered in full-time school. Last, tobacco use causes more than 1 million deaths each year in China, most of which are old men. Therefore, respondents aged above 60 have experienced a process of mortality selection, which could cause survival bias in estimation. We present the process of sample restriction step by step in the Appendix (see Table A1).

2.2. Smoking

The CFPS project measures smoking behavior with two variables: smoking status and the number of cigarettes smoked per day. The first variable is a dummy variable that equals one if the respondent reports having ever smoked in the past 30 days, zero otherwise. The second one is the average number of cigarettes the respondent consumes per day. We use both as the dependent variables in this study.

2.3. Personality traits, attitudes, and family structures

In 2018, based on the five-factor (Big 5) scale, the CFPS project assesses respondent's personality trait with a module of 15 items. The Big 5 model, which provides a suggested taxonomy of personality traits, has been academically accepted and widely used by psychologists since the 1980s (Goldberg, 1993). Because the traditional Big 5 personality inventories are very time-consuming, psychologists have developed some brief versions for large-sample comprehensive surveys. The sister surveys of the CFPS, such as the Panel Study of Income Dynamics (PSID), German Socio-Economic Panel (GSOEP), and British Household Panel survey (BHPS), all used 15-item versions. The short versions are found to reach acceptable levels in internal consistency, stability across time, discriminant validity, and convergent validity (Hahn et al., 2012). The CFPS adopts the same personality inventory used in PSID.

This study focuses on two dimensions of the Big 5 scale, conscientiousness and neuroticism. Conscientiousness is a tendency to display self-discipline and act dutifully, and neuroticism is the tendency to experience negative emotions. Psychologists have found both of these traits to be relevant to smoking behaviors (Malouff et al., 2006).

We add the scores for each personality dimension, and then divide the sample into two groups of similar size according to respondents' scores in each dimension. The dichotomization transforms interval scales into ordinal scales, which are more convenient in presenting and comparing the treatment effects by personality types. More specifically, we conduct statistical analyses with different subsamples separately to see whether the effects vary across them. Ordinal-scale measurements can preserve the mathematical characteristics of interval-scale measurements, and generate relatively conservative estimates (Stevens, 1951). In theory, mean value is more relevant to interval scale, while median value is more relevant to ordinal scale. We thus use the median value as the cutoff point for dichotomization. Finally, 56% of respondents are classified as conscientious while the others are not, and 51% as neurotic while the others not.

Based on respondents' answers to the questions regarding to the importance of having a "loving relationship with spouse" and "a happy and harmonious family", we construct a dummy variable indicating family attitude. The score for the answer ranges from 1 to 5 points, with 5 indicating the highest importance and 1 indicating the lowest. People who score 5 in both questions are considered as having a high pro-family attitude, and all others are considered low. Given the uneven distribution of scores, the distribution shows that 61% of adult men attach importance to their families.

The intensity of passive smoking also depends on one's family structure. Intuitively, smoking's negative externality would be stronger in the following conditions: (a) respondent doesn't live alone; (b) respondent is married. In this study, we consider respondents whose family structures satisfy both condition (a) and condition (b) as the subsample whose smoking behaviors would cause higher externalities, and the others as the subsample causing lower externalities. For a robustness check, we also redefine the "high-externality" subsample as respondents who not only satisfy the two conditions above but also have at least one child under 16 living in the household.

2.4. The COVID-19 closure policies in China

To capture government responses to the COVID-19 pandemic, the

Oxford COVID-19 Government Response Tracker (OxCGRT) project constructs an index to assess the strictness of government COVID-19 responses worldwide (Hale et al., 2021). It is a weighted average of nine ordered items: school closures, workplace closures, cancellation of public events, restrictions on public gatherings, public transport closures, stay-at-home requirements, public information campaigns, restrictions on internal movements, and international travel controls. The stringency index ranges from 0 to 100, with 100 indicating governments that implemented the most stringent policies. The data has been widely used in recent studies of public health (Toffolutti et al., 2022).

After lifting the COVID-19 lockdown in Wuhan on April 8, 2020, the Chinese government has remained vigilant against the spread of COVID-19. Local officials are authorized to implement closure policies for pandemic control. The OxCGRT project also provides a daily stringency index for each province in China. Our study uses it to construct the key independent variable because it can well capture the overall toughness of a province's closure policies. Fig. A1 shows temporal and regional variations in the stringency index across provinces during the period of the CFPS 2020 survey.

We collect the daily reported cases from the National Health Commission and the health commissions of each province to calculate the local COVID-19 incidence rate. Provincial governments officially classify cases into two types: local cases refer to people infected within the mainland area, and imported cases refer to overseas travelers who were detected entering the country before the end of their quarantine. Because imported cases are well under control, we only focus on the local cases, which are relevant to respondents' perceived risk of infection. We sum the local cases in each province to get the total number over the last 30 days before the respondent was surveyed, and then divide the total number by the province's population (in ten million) size in the 2020 census to calculate the local incidence rate.

3. Empirical strategy

3.1. Model specification

Our study examines how people change their smoking behaviors as governments implement stricter closure policies, and then investigates the role of family altruism in shaping behavior changes. It's reasonable to assume people stay at home more under stricter closure policies. In this situation, if people smoke, their family members would suffer more from passive smoking than before. We run a logistic regression, whose dependent variable is whether respondents had smoked in the past 30 days, on the strictness of closure as follows:

$$Logit(Prob[Smoking2020 = 1]) = \beta SIndex30_{iptm} + \gamma Cigar2018_{iptm} + \alpha X_{iptm} + \lambda_p + \lambda_m$$

i refers to the individual; p refers to the province; t refers to the interview date; m refers to the interview month. The β is the coefficient of interest, whose exponential form indicates the adjusted odds ratio of the stringency index. Because smoking is an addictive consumption, a man's tobacco use today is highly correlated with his use yesterday. The advantage of longitudinal data is that it permits us to control for respondents' cigarette consumption before the pandemic. Here we take the natural logarithm of cigarettes consumed per day in 2018 plus one, as $Cigar2018_{iptm}$, for less disturbance by extreme values. X_{iptm} represents a vector of sociodemographic characteristics in 2018. It includes age, the square of age, education attainment, marital status, whether residing in an urban area, the primary classification of occupations (in eight classifications), the natural logarithm of job income in the last 12 months (Chinese Yuan), the natural logarithm of family size, whether living with a child under 16, whether in the labor market, self-rated socio-economic status of the family when aged 14 (from one to five, as a factor variable), whether having clinically significant symptoms of depression in 2018 (denoted one as C-ESD scores $\geq$ 8, zero otherwise), and whether having a chronic disease diagnosed by the doctor in 2018. The formula includes province and interview month fixed effects (denoted as λ_p and λ_m), removing unobserved confounders unchanging at these two aggregate levels. The standard error is clustered at the province level.

The number of cigarettes smoked per day is the proxy of respondents' smoking frequency, and our study applies a generalized linear model to investigate:

$$NegativeBinomial(Cigar2020) = \beta SIndex30_{iptm} + \gamma Cigar2018_{iptm} + \alpha X_{iptm} + \lambda_p + \lambda_m$$

The dependent variable, *Cigar*2020, represents the number of cigarettes smoked per day in 2020. Because the variance of *Cigar*2020 is overly larger than its mean, we use negative binomial regression rather than Poisson regression for analyses. The Ordinal Least Square is not suitable for the number of cigarettes per day distributed in positive skewness. The standard error is clustered at the province level.

3.2. A quasi-natural experiment

The relationships between smoking behaviors and environments are endogenous in theory, and thus difficult to identify in empirical studies. Dunbar et al. (2021) recently used the exogenous assignment of military personnel as a natural experiment to investigate the impacts of social environments (e.g., local smoking prevalence) on smoking behaviors. Because about 90% of the respondents in CFPS 2020 were interviewed via telephone and the order of interview is randomly assigned by computer, we can consider the toughness of local closure policies in the past 30 days before the interview as exogenous. In other words, the research design of this study is close to a quasi-natural experiment and our estimates can be understood as causal effects (additional discussion can be found in Appendix I).

We aim to estimate the net effects of two opposite forces on smoking behaviors: policy-triggered anxiety and awareness of smoking's negative externalities. However, in addition to these two effects, closure policies might reduce smoking behaviors because of policy-induced economic difficulties, thus cutting a family's consumption budget. Although the reduction in cigarette consumption might be a man's altruistic choice when the family budget is tight, it's still different from the awareness of negative externalities, the mechanism in which we have the most interest. Therefore, we control a rich set of post-treatment socio-economic variables in the regression to block potential mediation via family budget constraints.

4. Results

4.1. Descriptive statistics

Table 1 reports the descriptive statistics of all main variables used in our regression analyses. The mean age in our sample is 42.19 years old, and 54% of respondents live in urban areas. About 56% of men had smoked in the past 30 days when interviewed in 2020, a slight decrease from 57% in 2018. On average, people consumed 7.92 cigarettes per day in 2020, slightly lower than the 8.38 cigarettes per day in 2018. The mean of the stringency index in the past 30 days is 52.08, with a standard deviation of 9.91. Over the past 30 days, the average local incidence rates within the province indicate that 0.45 in ten million Chinese people had been diagnosed with COVID-19 during the observation window.

4.2. Stringency of closure policies and smoking

Table 2 shows the COVID-19 closure policies in China discourage smoking behaviors under different measurements. According to Column (2), the odds ratio for the government stringency index is 0.941, and the average marginal effect on the probability is −0.006. According to the

Table 1
Descriptive statistics.

Variable	N	Mean/ Percent	Std. dev.	Sample size	Source
Health Status					
Smoking in the last month 2020	4026	56%		2237	*a*
Smoking in the last month 2018	4026	57%		2287	*a*
Number of cigarettes smoked per day 2020	4026	7.92	9.67		*a*
Number of cigarettes smoked per day 2018	4026	8.38	10.13		*a*
ln (number of cigarettes smoked per day+1) 2018	4026	1.44	1.37		*a*
Clinically significant symptom of depression 2018	4026	24%		968	*a*
With chronic disease diagnosed by a doctor	4026	11%		440	*a*
COVID-19 Relates					
Average stringency index in the last month	4026	52.08	9.91		*b*
Local incidence rates in the last month	4026	0.45	3.62		*c, d*
Personality Traits					
Conscientiousness	4025	11.48	1.89		*a*
Being conscientiousness	4025	56%		2258	*a*
Neuroticism	4024	8.61	2.12		*a*
Being neuroticism	4026	51%		2050	*a*
Attitudes to Family					
Loving relationship with spouse	4019	4.47	0.87		*a*
A happy and harmonious family	4025	4.70	0.64		*a*
Being pro-family	4019	61%		2456	*a*
Family Structure					
Marital status					*a*
Unmarried or cohabitated	4026	15%		589	
In marriage	4026	81%		3248	
Divorce or widower	4026	5%		189	
Family size	4026	4.21	2.03		*a*
ln (family size)	4026	1.31	0.54		*a*
Family having a child under 16	4026	67%		2685	*a*
Socio-demographic Characteristics					
Age	4026	42.19	11.15		*a*
Education Attainment					*a*
Uneducated	4026	8%		307	
Primary school	4026	18%		727	
Junior high school	4026	36%		1459	
Senior high school	4026	19%		763	
Higher Education	4026	19%		770	
Residence in urban	4026	54%		2168	*a*
Being in labor market	4026	93%		3758	*a*
Occupation classification					*a*
Inapplicable	4026	2%		95	
Header of state or private unit	4026	7%		297	
Profession and skilled worker	4026	8%		341	
Office staff and related personnel	4026	7%		269	
Commercial and service worker	4026	13%		514	
Farmer and water conservancy staff	4026	24%		983	
Production and transportation operator	4026	36%		1465	
Unclassified and others	4026	2%		62	
ln (wage in the last year)	4026	6.84	5.11		*a*
Self-rated socio-economic status aging 14					*a*
Very low	4026	8%		332	
Low	4026	13%		543	
Middle	4026	45%		1830	
High	4026	17%		697	
Very high	4026	15%		624	

Note: source *a* refers to the CFPS project; *b* refers to the OxCGRT project; *c* and *d* refer to the National Health Commission and Health Commission of provinces. Local incidence rates in the last month are measured as the new cases happened in the province per ten million people.

Table 2
Baseline results: the effects of closure policies on smoking behaviors.

	(1)	(2)	(3)	(4)
Model Specification	Logistic regression		Negative binomial regression	
Dependent Variable	*Smoking last month 2020*		*# of Cigarettes per day in 2020*	
Reported Coefficients	Odds ratios		Incidence-rate ratios	
Stringency Index 30	0.968**	0.941***	0.984**	0.973***
	(0.015)	(0.016)	(0.008)	(0.007)
ln(#cigarettes+1) 2018		6.060***		2.650***
		(0.480)		(0.113)
Reported Coefficients	Average marginal effects			
Stringency Index 30	−0.008**	−0.006***	−0.127**	−0.235***
	(0.004)	(0.002)	(0.064)	(0.062)
Controls & FE	YES	YES	YES	YES
Num. Obs.	4026	4026	4026	4026
Pseudo-R-squared	0.035	0.538	0.005	0.101

Note: Robust standard errors clustered at the province level are shown in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Control variables include age, the square of age, education attainment, marital status, whether residing in an urban area, the primary classification of occupations (in eight classifications), the natural logarithm of job income last 12 months (Chinese Yuan), the natural logarithm of family size, whether living with a child under 16, whether being in the labor market, self-rated socio-economic status of the family when aged 14 (from one to five, as a factor variable), whether having clinically significant symptom of depression in 2018 (denoted one as C-ESD scores ≥ 8, zero otherwise), and whether having chronic disease diagnosed by the doctor in half a year in 2018. The regression includes province and interview month fixed effects.

coefficients, if the mean stringency index increased 10 points over the past 30 days, the average probability of smoking would decrease by 6 percent points. The full table of baseline results, which also presents the coefficients of control variables, can be found in Table A2.

The effects of the 30-day stringency index on the number of cigarettes consumed per day are also significantly negative. As shown in Column 4, the average marginal effect of closure policies is 0.235, which suggests that a 10-point increase in the index decreases the average cigarettes consumed per day by 2.35. Given that adult men consume on average 7.93 cigarettes per day in our sample, the effect is economically significant.

4.3. The effects by smoking status in 2018

We are also interested in whether the effects of closure policies are dependent on respondents' historical smoking status. Based on respondents' answers to the smoking-status question in CFPS 2018, we split the sample into two groups, respondents who reported they had smoked in the past 30 days when surveyed in 2018 and respondents who reported that they had not. Table 3 reports the analysis results for the two groups. Columns 1 and 2 show that, under stricter closure policies, people who smoked in 2018 have a higher probability of quitting, and people who didn't smoke in 2018 have a lower probability of starting

Table 3
The effects of closure policies by smoking status in 2018.

	(1)	(2)	(3)	(4)
Whether Smoking 2018	No	Yes	No	Yes
Model Specification	Logistic regression		Negative binomial regression	
Dependent Variable	*Smoking last month 2020*		*# of Cigarettes per day 2020*	
Reported Coefficients	Odds ratios		Incidence-rate ratios	
Stringency Index 30	0.940**	0.926***	0.943	0.992
	(0.025)	(0.021)	(0.051)	(0.006)
ln(#cigarettes+1) 2018		2.981***		2.117***
		(0.287)		(0.094)
Reported Coefficients	Average marginal effects			
Stringency Index 30	−0.006**	−0.006***	−0.078	−0.106
	(0.002)	(0.002)	(0.082)	(0.079)
Controls & FE	YES	YES	YES	YES
Num. Obs.	1739	2254	1739	2287
Pseudo-R-squared	0.080	0.146	0.024	0.060

Note: Robust standard errors clustered at the province level are shown in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Control variables include age, the square of age, education attainment, marital status, whether residing in an urban area, the primary classification of occupations (in eight classifications), the natural logarithm of job income last 12 months (Chinese Yuan), the natural logarithm of family size, whether living with a child under 16, whether being in the labor market, self-rated socio-economic status of the family when aged 14 (from one to five, as a factor variable), whether having clinically significant symptom of depression in 2018 (denoted one as C-ESD scores ≥ 8, zero otherwise), and whether having chronic disease diagnosed by the doctor in half a year in 2018. The regression includes province and interview month fixed effects.

smoking. The two average marginal effects of closure policies are both around −0.006. Columns 3 and 4 show the negative associations between the number of cigarettes smoked per day and the stringent policies, but the coefficients are insignificant. One possible reason is that the shrinking sample size leads to large standard errors. The findings suggest that strict closure policies lead smokers to cease, and dissuade nonsmokers from starting.

4.4. Further heterogeneity analyses

The negative effects of closure policies on smoking suggest that people care about the health consequences on their families. To validate this mechanism, we further explore the heterogeneity of the effects by taking into account the difference in altruism. If respondents smoke less under strict closure policies because they consider the negative externalities of smoking on their families, conscientious people and people with pro-family attitudes would make more changes in smoking behaviors. Therefore, as closure policies become tougher, we should observe that conscientious respondents or respondents with pro-family attitudes have more reductions in tobacco consumption than others.

Table 4 reports the results of smoking behaviors and the estimated average marginal effects with different subsamples. Conscientious respondents smoked significantly less than the lower group in 2018 (about −0.033 after controlling province fixed effects). Their average number of cigarettes per day is also lower, though insignificant. There are no significant differences in smoking behaviors between the high and low pro-family groups. In Columns 1 and 3 of Panel A, the stringency of closure policies significantly reduces smoking behaviors for respondents whose conscientiousness is above the median (−0.007 on smoking status and −0.505 on the number of cigarettes per day). The estimates with the subsample of people whose conscientiousness is below the median are weaker and statistically insignificant. Panel B reports the estimates with the subsamples that are grouped by the strength of pro-family attitude. All these findings support our hypothesis that the decline in smoking under stricter closure policies is done for the consideration of their families.

After showing the role of respondents' intrinsic characteristics in

Table 4
The effects of closure policies by conscientiousness personality trait and family attitude.

	Panel A: classified by conscientiousness (average marginal effects)			
	(1)	(2)	(3)	(4)
Model Specification	Logistic regression		Negative binomial regression	
Dependent Variable	*Smoking last month in 2020*		*# of cigarettes per day in 2020*	
Subsample	Above median	Below median	Above median	Below median
Mean in 2018	0.55 (0.02)	0.59 (0.02)	8.35 (0.35)	8.42 (0.33)
Difference (std. dev.)	−0.035*** (0.013)		−0.069 (0.309)	
controlled with the province FE	−0.033** (0.013)		−0.089 (0.301)	
Stringency Index 30	−0.007**	−0.004	−0.505***	0.018
	(0.003)	(0.003)	(0.003)	(0.005)
Controls & FE	YES	YES	YES	YES
Num. Obs.	2258	1767	2258	1767
Pseudo-R-squared	0.557	0.539	0.110	0.102
	Panel B: classified by pro-family attitude (Average marginal effects)			
	(1)	(2)	(3)	(4)
Model Specification	Logistic regression		Negative binomial regression	
Dependent Variable	*Smoking last month in 2020*		*# of cigarettes per day in 2020*	
Subsample	Above median	Below median	Above median	Below median
Mean in 2018	0.57 (0.02)	0.56 (0.02)	8.53 (0.36)	8.17 (0.33)
Difference (std. dev.)	0.011 (0.018)		0.365 (0.347)	
Controlled with the province FE	0.020 (0.017)		0.535 (0.339)	
Stringency Index 30	−0.007**	−0.003	−0.254**	−0.132
	(0.003)	(0.005)	(0.102)	(0.189)
Controls & FE	YES	YES	YES	YES
Num. Obs.	2456	1563	2456	1563
pseudo-R-squared	0.548	0.555	0.100	0.115

Note: Robust standard errors clustered at the province level are shown in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Control variables include age, the square of age, education attainment, marital status, whether residing in an urban area, the primary classification of occupations (in eight classifications), the natural logarithm of job income last 12 months (Chinese Yuan), the natural logarithm of family size, whether living with a child under 16, whether being in the labor market, self-rated socio-economic status of the family when aged 14 (from one to five, as a factor variable), whether having clinically significant symptom of depression in 2018 (denoted one as C-ESD scores ≥ 8, zero otherwise), and whether having chronic disease diagnosed by the doctor in half a year in 2018. The regression includes province and interview month fixed effects.

Table 4, we move on to discuss family structure, which determines the intensity of smoking's negative externalities. First, we denote an intense scenario by including married people with at least one family member. Second, we constrain the targeted group whose members have at least one child below 16 years old in 2020. The closure policies should be robustly effective to people in the two targeted scenarios, while the influence on excluding groups should not remain negative steadily.

We first simply illustrate the changes in the amount of smoking by the respondent's family structure in Fig. 1, which shows a decreasing trend for married men who live with their families and an increasing trend for men who are unmarried or live alone. Table 5 reports the results of further analysis by family structures. The difference in the mean of the smoking behavior implies the drawback of naïve comparisons of smoking behavior on family characteristics: smokers who theoretically

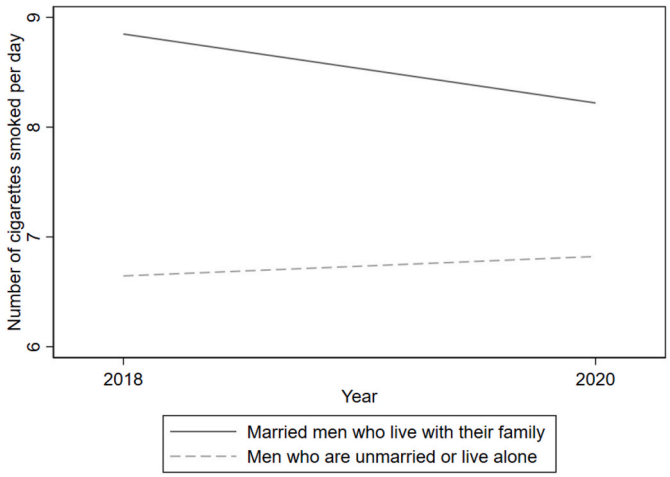

Fig. 1. The changing smoking behavior before and after the COVID-19 breakout in China.
Source: the CFPS project.
Note: The chart shows how number of cigarettes smoked per day change across men with different family structures. The sample includes Chinese male adults who have leaved school, between their ages of 18 and 60 in 2020.

cause the worst consequences for their family members in the same stringent closure policies might smoke more frequently each day. In Columns 1 and 3 of Panel A and B, the mean of the stringency index over 30 days concerning smoking behaviors shows adverse and significant effects for the people whose family members have high potential exposure; the estimated average marginal effects on smoking behaviors are stronger than the untargeted group (Columns 2 and 4 in both panels). Both sub-classifications of intrinsic attributes to observed family structures report identical patterns of the closure policies' impacts on smoking behaviors. Whether the average smoking behaviors of targeted groups in 2018 are higher or lower than the other groups, the patterns are consistent with our family altruism hypotheses. Although the sub-classification cannot statistically test for significant differences in the two average marginal effects, the effect sizes of groups with high family altruism are uniformly more than the comparison groups.

We also explore the policy-triggered-anxiety hypothesis, which predicts that people would smoke more under COVID-19 closure policies because they are more anxious. Existing literature shows that a person with the neuroticism trait would feel more severe anxiety than others when facing a negative shock (Staneva et al., 2022; Vollrath and Torgersen, 2000). Moreover, a man with clinically significant depressive symptoms might smoke more when facing a stricter policy because they require more cigarettes to relieve triggered stress. Therefore, when individuals are very anxious or depressed, they may not be able to consider the well-being of others. To examine this theory, we divided the sample by the respondent's neuroticism trait in the Big 5 personality factors or whether he was suffering from clinically significant depression in 2018.

Table 6 shows that compared with the other groups, respondents with neuroticism scores above the median and respondents with clinically significant depressive symptoms in 2018 do not smoke less when facing stricter closure policies. This is consistent with the hypothesis stating that actively adjusting smoking behaviors occur only for individuals with healthy mental states.

5. Robustness check

The local incidence rate of COVID-19 seems to confound our research design, which triggers both the government's policy changes and citizens' behavioral responses. Controlling the local incidence rates, however, creates additional problems. The local incidence rate might

Table 5
The effects of closure policies by family structures.

	Panel A: family size over one + being married (Average marginal effects)			
	(1)	(2)	(3)	(4)
Model Specification	Logistic regression		Negative binomial regression	
Dependent Variable	*Smoking last month in 2020*		*# of cigarettes per day in 2020*	
Subsample	Yes	No	Yes	No
Mean in 2018	0.58 (0.02)	0.52 (0.02)	8.85 (0.33)	6.64 (0.35)
Difference (std. dev.)	0.064*** (0.022)		2.203*** (0.374)	
controlled with the province FE	0.063** (0.021)		2.132*** (0.358)	
Stringency Index 30	−0.007*** (0.002)	−0.002 (0.005)	−0.339*** (0.087)	0.149 (0.173)
Controls & FE	YES	YES	YES	YES
Num. Obs.	3187	839	3187	839
pseudo-R-squared	0.549	0.559	0.106	0.112
	Panel B: family size over one + being married + having a child under 16 (Average marginal effects)			
	(1)	(2)	(3)	(4)
Model Specification	Logistic regression		Negative binomial regression	
Dependent Variable	*Smoking last month in 2020*		*# of cigarettes per day in 2020*	
Subsample	Yes	No	Yes	No
Mean in 2018	0.60 (0.02)	0.52 (0.02)	9.14 (0.36)	7.36 (0.28)
Difference (std. dev.)	0.078 (0.017)		1.778*** (0.268)	
controlled with the province FE	0.077 (0.017)		1.718*** (0.253)	
Stringency Index 30	−0.006*** (0.002)	−0.004 (0.002)	−0.371*** (0.083)	−0.006 (0.121)
Controls & FE	YES	YES	YES	YES
Num. Obs.	2302	1724	2302	1724
pseudo-R-squared	0.537	0.571	0.098	0.119

Note: Robust standard errors clustered at the province level are shown in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Control variables include age, the square of age, education attainment, marital status, whether residing in an urban area, the primary classification of occupations (in eight classifications), the natural logarithm of job income last 12 months (Chinese Yuan), the natural logarithm of family size, whether living with a child under 16, whether being in the labor market, self-rated socio-economic status of the family when aged 14 (from one to five, as a factor variable), whether having clinically significant symptom of depression in 2018 (denoted one as C-ESD scores ≥ 8, zero otherwise), and whether having chronic disease diagnosed by the doctor in half a year in 2018. The regression includes province and interview month fixed effects.

endogenously determine the strictness of government policies; however, researchers are blind to the actual policymaking, making the formula containing the local incidence rate sensitive to the assumed functional form. Adding the local incidence rate also disrupts our interpretation of the closure policies.

We include the COVID-19 local incidence rate from the previous 30 days per ten million people as a control variable to check robustness. Table A3 reports the robustness checking results. The positive coefficients of the local incidence rate imply that it might trigger people's anxiety and induce more smoking. The coefficients of the stringency index over the last 30 days are still significantly negative. After controlling for the number cigarettes smoked in 2018, the average marginal effect of Stringency Index 30 to the probability of smoking is unchanged at −0.00. Meanwhile, the average marginal impact of closure policies on cigarettes in 2020 increases to −0.250.

Because the follow-up rate in CFPS 2020 is relatively lower than in previous waves, another concern about the baseline results is mainly driven by some specific groups. It could diminish the external validity of

Table 6
The effects of closure policies by neuroticism personality trait and depressive symptom.

	Panel A: classified by neuroticism (Average marginal effects)			
	(1)	(2)	(3)	(4)
Model Specification	Logistic regression		Negative binomial regression	
Dependent Variable	*Smoking last month in 2020*		*# of cigarettes per day in 2020*	
Subsample	Above median	Below median	Above median	Below median
Mean in 2018	0.57 (0.02)	0.57 (0.02)	8.41 (0.36)	8.35 (0.31)
Difference (std. dev.)	−0.008 (0.020)		0.058 (0.290)	
controlled with the province FE	−0.019 (0.019)		−0.083 (0.271)	
Stringency Index 30	−0.003 (0.002)	−0.009*** (0.003)	−0.165 (0.104)	−0.315*** (0.104)
Controls & FE	2050	1976	2050	1976
Num. Obs.	0.540	0.555	0.101	0.116
pseudo-R-squared	YES	YES	YES	YES
	Panel B: classified by depressive symptom (Average marginal effects)			
	(1)	(2)	(3)	(4)
Model Specification	Logistic regression		Negative binomial regression	
Dependent Variable	*Smoking last month in 2020*		*# of cigarettes per day in 2020*	
Subsample	With	Without	With	Without
Mean in 2018	0.60 (0.02)	0.56 (0.02)	8.74 (0.40)	8.27 (0.31)
Difference (std. dev.)	0.037* (0.019)		0.470 (0.322)	
controlled with the province FE	0.026 (0.019)		0.300 (0.301)	
Stringency Index 30	−0.003 (0.003)	−0.007*** (0.002)	−0.185 (0.181)	−0.250*** (0.058)
Controls & FE	968	3058	968	3058
Num. Obs.	0.546	0.546	0.128	0.101
pseudo-R-squared	YES	YES	YES	YES

Note: Robust standard errors clustered at the province level are shown in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Control variables include age, the square of age, education attainment, marital status, whether residing in an urban area, the primary classification of occupations (in eight classifications), the natural logarithm of job income last 12 months (Chinese Yuan), the natural logarithm of family size, whether living with a child under 16, whether being in the labor market, self-rated socio-economic status of the family when aged 14 (from one to five, as a factor variable), whether having clinically significant symptom of depression in 2018 (denoted one as C-ESD scores ≥ 8, zero otherwise), and whether having chronic disease diagnosed by the doctor in half a year in 2018. The regression includes province and interview month fixed effects.

our conclusion. To address this concern, we use the inverse probability weighting (IPW) method and reconduct the baseline analyses. More specifically, the logistic regression approximates the probability of successfully re-interviewing men aged between 16 and 58 in 2018, in the 2020 sample. The dependent variable is whether to make the self-reported response in 2020. Moreover, to predict more precisely, the explanatory variables in 2018 consider whether the respondents register as an agricultural hukou, urban-rural residence type, their ages, the square of age, education attainments, C-ESD scores, whether they had had a chronic disease diagnosed by a doctor in the past half a year, and the province fixed effects. As shown in Table A4, the new results are similar to our baseline results in Table 2.

We explain the decline in smoking with the respondent's altruism, but other alternative explanations also exist. The closure policies not only prompt men to stay home more, but also change their lives in all dimensions. First, shortly after the outbreak of COVID-19, the central government recommended that citizens wear masks and local governments introduced more specific regulations requiring residents to wear a mask in shared/public spaces. The reduction in smoking could be induced by the mask-wearing requirements, which make smoking more inconvenient in shared/public spaces. The OxCGRT project has a specific index to measure the stringency of facial-covering requirements, which ranges from 0 to 4, 0 for "no policy" and 4 for "required outside the home at all times regardless of location or presence of other people". We take the average of this index in the past 30 days as an independent variable and put it into regressions with the remaining components of the stringency index. The results in Table A5 show that our baseline estimates are almost the same after separating the stringency index of facial-covering requirements from the general index. Second, the consumption of cigarettes needs time and closure policies disrupt the normal pattern of time use. Men may smoke less because they have less time to do so under closure policies. To exclude this potential alternative explanation, we include the changes of time used in different activities (e.g., housework, watching TV or movie, sleep) as control variables and find our findings still hold (also see Table A5).

The stringency index used in this study is the sum of nine ordered items in OxCGRT, which implicitly assigns equal weight to each item. However, some items could be more relevant to a man's daily life than others, and then such an aggregated measure could be imprecise. To address this concern, we exclude the items less relevant to a man's daily life from the construction of the stringency index step by step and generate new indices. Table A6 presents the steps: (1) first exclude item H1 ("public information campaigns") from *Stringency Index* and generate a new independent variable *Weighted Index A*; (2) then exclude items C7 ("restrictions on internal travel") and C8 ("international travel controls") from *Weighted Index A*, and generate *Weighted Index B*; (3) finally, we exclude items C1 ("school closing") and C2 ("cancel public events") from *Weighted Index B* to obtain *Weighted Index C*. Then we reconduct the baseline regression analyses with these new indices and report the results in Panel B of Table A6. In general, the coefficients of new indices are close to that of *Stringency Index*. In other words, our findings are robust to different weights used in aggregating items.

Even though the survey date was theoretically random, regression on the actual interview day (defined June 30, 2020, as zero) shows a slight statistical difference in the observed data (see Table A7). After controlling for the province fixed effects and the interview month fixed effects, most variables are not significant at the 0.1 level, or the effect sizes are limited compared to the changing level of the stringency index over the previous month. Otherwise, the strictness of closure policies fluctuates up and down randomly, independently deciding the treatment status under a slight systematical bias. Therefore, our exogenous assumptions of the random interview time and order are likely to hold.

In the main analyses, we adopt the likewise deletion approach, which deletes from the sample any observations that are missing data on any variables in the model of interest. Then, about 2.7% (112 out of 4138) of respondents are dropped from the sample. Missing value on the variable residential status (urban/rural hukou) contributes to more than 80% of these missing-data observations. Based on the *missing at random* (MAR) assumption, we impute the missing value of residential status with observable variables (Allison, 2001). More specifically, we run a Logit regression to predict the likelihood of being an urban resident with all other control variables. If the predicted likelihood is not less than 50%, the missing value of residential status is replaced with "urban", otherwise, with "rural". We reconduct regression analyses with the imputed sample, and report the results in Table A8. The new results are very close to our baseline results.

6. Concluding discussions

Our study finds that people reduce smoking under stringent closure policies for COVID-19 in China. More specifically, the closure policies

encourage smokers to smoke less or even cease smoking, and dissuade nonsmokers from taking up the habit of smoking. A potential driver of these effects is family altruism, which varies across intrinsic characteristics and living arrangements, including conscientiousness personality traits, pro-family attitudes, and specific family structures. A growing scientific literature has examined how COVID-19 lockdown policies affect population health (Jain and Dupas, 2022; O'Donnell et al., 2022; Qi et al., 2022; Sachser et al., 2021). Lockdown, which is among the toughest measures of closure policies, had only been temporarily adopted by governments. In contrast, our study focuses on the impacts of general closure policies on smoking behaviors.

We further conduct several robustness checks to ensure that our findings are valid. First, governments respond to COVID-19 incidence by changing policies, and individuals respond to COVID-19 incidence by changing behaviors. Therefore, COVID-19 incidence could be an omitted variable that induces a spurious relationship between closure policies and smoking behaviors. To address this concern, we include the COVID-19 incidence rate at the province level into our regressions and find the coefficients almost unchanged. Second, even though the CFPS sample is nationally representative, the external validity of this study could be limited because some respondents in CFPS 2018 are not followed up by the CFPS 2020 survey. We estimate and predict the inverse probability of responding in 2020 as a weight of the regression and find the new results are consistent with previous ones. Third, our identification strategy assumes that the timing when a respondent was surveyed is uncorrelated with omitted variables, but the timing of the survey could be affected by COVID-19 closure policies. We don't consider this as a major threat to our findings. On the one hand, 89.1% of all the respondents in CFPS 2020 were surveyed by telephone and the order of telephone calls was randomly assigned by a computer. On the other hand, we run a regression on the responding dates and find the survey date is uncorrelated with most socio-demographic variables.

When one's consumption has strong externalities, a man will interact with his family dynamically to decide how much he could consume. Therefore, at any time point, his consumption behaviors are at the equilibrium or are converging toward the equilibrium. It is difficult to empirically test any hypothesis regarding the relationship between second-hand smoke and people's concern for their family members within the framework of causal inference. This study contributes to understanding the causal impacts of families on smoking behaviors among traditional ethnographic studies, because the closure policies are relatively exogenous. We also extend the traditional economic model of addictive consumption by considering psychological factors.

Because smoking is a kind of addictive consumption, promoting smoking cessation is a challenging job for policymakers. For each 1-percent increase in state cigarette taxes in the United States, cigarette sales would fall by only 0.6 percent, which suggests the price elasticity is around −0.6 (Peterson et al., 1992). In China, the short-run price elasticity of cigarette consumption in the period of 1980–1997 is about −0.35 (Hu and Mao, 2002). Our study shows that the average cigarette consumption per day dropped by 6 percent from 2018 to 2020. According to the estimates of price elasticity in previous studies, such a decline would be equal to the effect of a tax increase of 10–17%.

Our work verifies the potential power of family attitudes and personality traits for reducing tobacco dependence, and has strong policy implications. First, our study relates to how public health policies shape environmental tobacco smoke (ETS) in the home, which previous studies might overlook. Evidence suggests that public smoking bans reduce smoking behaviors for smokers who spend time in restrictive areas (Anger et al., 2011; Evans et al., 1999; Lin et al., 2020), and these regulations successfully regulate ETS and improve nonsmokers' health conditions. Bharadwaj et al. (2014) identify that extending smoking bans to bars and restaurants improves the health of female workers' babies. However, the global effects of smoke-free policies might indirectly encourage smoking at home and then shift ETS risks to smokers' families. Adda and Cornaglia (2010) find that smoking bans harm nonsmokers by displacing smokers to private places, leading to unintended consequences for children. Our study suggests that, when designing public health measures, policymakers should take altruism into account because it can affect the outcomes.

No policy or intervention has been realized in the circumstances absent of social interaction, targeting an atomic individual with no heterogeneity. Recently, Tsoh et al. (2015) apply a social network family-based intervention to Chinese and Vietnamese American male smokers, obtaining high acceptability by diffusing the knowledge of health risks and cessation resources and constructing communication between smokers and their families. Public health scholars have realized the importance of family in shaping smoking behaviors, but still do not have sufficient understanding of smoking behaviors under family influences to build up a systematic framework for intervention design (Hubbard et al., 2016). Our results suggest that policymakers could use the family influence for encouraging smoking cessation by invoking smokers' perceptions of the potential negative externalities for their families.

Some limitations still remain in this study. First, partially because of the COVID-19 pandemic and related closure policies, the follow-up rate of the CFPS survey in 2020 is lower than in previous years. The data shows that only 62.5% of men over 15 in 2018 responded to the self-reported questionnaire in 2020. Nonetheless, the data quality of CFPS is as good as the top-level international surveys conducted in the same period. Compared to other contemporaneous studies using online surveys, small sample surveys, and case studies, our study takes the advantages of a national longitudinal survey project and thus is relatively more valid. Second, the estimates of this study mainly capture the short-term effects of closure policies. The long-term effects could be weaker because people might gradually adapt to environmental changes and find ways to consume cigarettes with less externalities. Third, the stringency index was generated at the province level and thus could not capture the variations in closure policies across lower-level administrative divisions. If closure policies vary greatly within a province, our empirical results tend to underestimate the true effects because of measurement errors. Finally, this article mainly investigates the impact of COVID-19 closure policies from the perspective of consumers' behaviors, but not from the supply side. If the policies are sufficiently tough, households could suffer from a shortage of supplies. In this scenario, men smoke less not because they choose to do so but because they can't get cigarettes. However, we don't think the supply of cigarettes would be an influential confounder. On one side, it can't explain why the reduction in smoking is more significant among men who are conscientious, pro-family, and living with their families. These respondents should be better prepared for policy uncertainties in advance. On the other, almost all respondents in CFPS 2020 were surveyed in the second half of 2020, when the COVID-19 pandemic had been well controlled in China and closure policies were not that tough.

Credit author statement

Weicheng Cai: Research design, Data analyses, Writing- Original draft. **Yi Zhou:** Conceptualization, Research design, Writing- Reviewing and Editing.

Acknowledgements

This study was supported by grant number 19YJC840064 from the China Ministry of Education Humanity and Social Science Foundation for Youth Scholars. The content is solely the responsibility of the author (s) and does not necessarily represent the official views of the sponsor. We would like to thank Wen Liu, Liyang Xie, Yu Xie, Feng Yang and the two anonymous reviewers for their constructive comments.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2022.115159.

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