

BMJ Open Patterns of smoking initiation during adolescence and young adulthood in South-West China: findings of the National Nutrition and Health Survey (2010–2012)

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ABSTRACT

Objective This study aims to understand the age patterns of smoking initiation during adolescence and young adulthood in South-West China, where the prevalence of tobacco use is reported as the highest in the country.

Design A cross-sectional study.

Setting The data were derived from the China National Nutrition and Health Survey in Yunnan Province, South-West China (2010–2012).

Participants A total of 4801 participants aged 15–65 years were included.

Primary outcome measures A survival model was used to estimate the hazard of smoking initiation by age and log-rank test was used to compare the hazard curves across subgroups (men/women, urban/rural, Han Chinese/ethnic minority).

Results The prevalence of current smoking among men and women were 60.4% (95% CI 58.2% to 62.6%) and 5.1% (95% CI 4.3% to 5.9%), respectively. Smoking was more prevalent among men and women of lower education and less income, as well as rural and ethnic minority women. Among the current smokers, cigarette (80.7%) was the most commonly used tobacco product, followed by waterpipe (10.8%) and pipe tobacco (8.5%). The hazards of smoking initiation were low for both men and women before the age of 15 years (1% for men and 0.05% for women); and the hazards increased quickly from age 15 years and peaked at 19 years (21.5% for men and 1.0% for women). Rural and ethnic minority women were at higher risk of smoking initiation than their counterparts between 15 years and 19 years of age ($\chi^2=44.8$, $p<0.01$; $\chi^2=165.2$, $p<0.01$) and no such difference was found in men.

Conclusions Findings of this study underscore the importance to implement tobacco prevention interventions among older teens and young adults in South-West China, especially for rural and ethnic minority women.

INTRODUCTION

Tobacco use is a leading preventable cause of morbidity and mortality across the globe.¹ As the world's largest producer and consumer

Strengths and limitations of this study

- This is the first study to examine the hazards of smoking initiation by age during adolescence and young adulthood in South-West China.
- The age, sex, and ethnic and cultural disparities in the hazards of smoking initiation revealed in this study are needed to develop targeted preventive interventions.
- As the sample was only from six counties in Yunnan Province, caution is needed to generalise the results to other places.

of tobacco, China has more than 300 million smokers and 740 million non-smokers exposed to secondhand smoke.² In 2010, an estimated 1 million deaths were attributed to tobacco smoking alone in China.³ This highlights the significance of implementing effective and culture-specific tobacco control interventions in China.

Persistent tobacco control efforts over the past 20 years have resulted in significant declines in tobacco smoking among Chinese adults.^{4,5} However, this decline is not uniform across various regions and among different population subgroups. For example, in 2010, an estimated 26.2% of adults in East China were current smokers, whereas the prevalence was 30.4% in West China.⁶ A study conducted in North-East China found that the prevalence of current smoking among women was as high as 9.4%, roughly four times that of the Chinese national average for women.^{6,7} Moreover, some studies have suggested that smoking might be more prevalent among the ethnic minority than Han Chinese.^{8,9} Similarly, a recent study from the USA has also shown a significant difference in cigarette smoking prevalence across different

ances such as: whites (24.9%) and Asians (10.9%).¹⁰ A study conducted by Chen *et al* on cigarette smoking in a multiethnic population reported significantly higher hazards of smoking initiation for white adolescents than their Asian counterparts.¹¹ Findings from this study implied that the disparity in smoking prevalence among adults might be attributed to the differences in smoking initiation during adolescence.¹¹ Studies from China and other countries have also confirmed that smoking initiation at a young age strongly predicts future smoking patterns including daily smoking, smoking intensity and difficulty quitting.^{12–14} Therefore, planning and implementing early intervention strategies to prevent smoking initiation among adolescents is one of the most promising strategies for tobacco control.¹⁵

Adolescence represents a high-risk period for smoking initiation and tobacco use behaviour development. After the first puff, many adolescents continue to experiment with tobacco products, leading to more regular use and ultimately nicotine addiction.¹⁶ This transition from smoking initiation to daily smoking can happen quickly or can take years.^{17 18} Ideally, smoking prevention programmes should begin before the period of maximum risk of smoking initiation and continue until after the maximum risk has ended. Although the average age of smoking initiation among smokers in China is approximately 21 years, most of them have started smoking long before that age.^{4 19} By using the survival model, Chen *et al* studied the hazard of smoking initiation by age among junior middle school students in Wuhan, China and reported a sharp increase after 12 years of age.¹⁴ New studies indicate that individuals start smoking at younger and younger ages.²⁰ Therefore, exploring the current age patterns of smoking initiation is essential to develop effective targeted tobacco prevention strategies.

Yunnan province is located in South-West China and has the most ethnic minorities. Yunnan province is also the main production and consumption hub for tobacco products, such as cigarettes, waterpipe and pipe tobacco. This study investigates the age patterns of cigarette smoking initiation in South-West China, as well as the disparities in sex, ethnicity and residence.

METHODS

Study design, setting and participants

This paper analysed data from the 2010–2012 China National Nutrition and Health Survey in Yunnan Province. Participants for this study were recruited using a multistratified cluster sampling method from six counties in Yunnan Province (Panlong, Gejiu, Luxi, Menglian, Ninglan and Shuifu). These six counties differ from each other in their geographical regions within the province, population sizes, ethnic groups and levels of economic development. These research sites adequately represent South-West China, and highlight the urban-rural differences.

From each of the above selected six counties, three townships were randomly selected followed by the random selection of three villages from each township. Next, from each village, 75 households were randomly selected and all members over 15 years of age from each of the selected households were invited to participate in the survey. A total of 4801 participants completed the survey, with a response rate of 97%. Signed informed consent was obtained from all the participants before the survey.

Patient and public involvement

This study is a population-based survey study. Patients and public were not involved.

Measures

Current smokers were defined as individuals who reportedly smoke any tobacco product currently. *Lifetime smokers* were defined as individuals who have a lifetime history of smoking.²¹ *Non-smokers* were defined as individuals who had never smoked. *Age of smoking initiation* was defined as the age at which a participant first puffed on any tobacco product including cigarette, pipe tobacco and waterpipe. For those who never smoked, their age at the time of data collection was used as the age of initiation. A dummy variable was used to separate these participants from the others and was used in the survival analysis to estimate the hazards of smoking initiation.

Several sociodemographic variables included in the analysis were: age at survey (in years), sex (men/women), ethnicity (Han/minority), residence (urban/rural), educational attainment (primary school or less, secondary school, high school or more) and yearly household income (Renminbi (RMB ¥), <5000, 5000–19 999, ≥20 000, US\$1=6.25¥). Ethnic groups were categorised as Han Chinese and ethnic minority because the majority of the population in South-West China is either Han Chinese or small groups of other ethnic minorities. These ethnic minorities follow similar lifestyles and hence were categorised as one group.²² Residence was categorised as urban (two county towns: Panlong, and Gejiu) and rural (rural villages in four counties: Luxi, Menglian, Ninglan and Shuifu), based on national criteria.²³

Statistical analysis

Hazards of smoking initiation by age. A survival analysis model was used to estimate the hazards of smoking initiation by a single year of age. The hazards of smoking initiation at any given age ($H(t)$) were defined as the ratio of the new smokers in the age over the total numbers of non-smokers at the beginning of this age. Therefore, $H(t)$ provides an estimation of an instantaneous probability of smoking initiation by age.

In the survival modelling analysis, a person who had initiated smoking was coded as a failure, while those who had not yet initiated smoking at the age of the survey were counted as censored. Taking advantages of survival modelling analysis, the age of these participants at the

Table 1 Demographic characteristics of the participants (n=4801)

	Total, n (%)	Men, n (%)	Women, n (%)	χ^2	P values
Age in years					
15~24	546 (11.4)	212 (10.9)	334 (11.7)	10.5	<0.01
25~44	2064 (43.0)	788 (40.6)	1276 (44.6)		
45~65	2191 (45.6)	940 (48.5)	1251 (43.7)		
Residence					
Urban	1430 (29.8)	557 (28.7)	873 (30.5)	1.8	0.18
Rural	3371 (70.2)	1383 (71.3)	1988 (69.5)		
Ethnicity					
Han	2939 (61.2)	1205 (62.1)	1734 (60.6)	1.1	0.29
Minority	1862 (38.8)	735 (37.9)	1127 (39.4)		
Household income (¥)					
<5000	1353 (29.5)	547 (29.4)	806 (29.6)	0.04	0.98
5000~19999	2662 (58.1)	1082 (58.1)	1581 (58.1)		
≥20000	567 (12.4)	232 (12.5)	335 (12.3)		
Educational attainment					
Primary school or less	2510 (52.3)	899 (46.3)	1611 (56.3)	47.4	<0.01
Secondary school	1534 (32.0)	710 (36.6)	824 (28.8)		
High school or more	757 (15.7)	331 (17.1)	426 (14.9)		
Total	4801 (100.0)	1940 (40.4)	2861 (59.6)		

survey time was included for analysis to fully use the information provided by these participants.²⁴

Plots of $-\log(S(t))$ over age and $\log(-\log(S(t)))$ against $\log(\text{age})$ were used to verify empirically whether the distribution of the hazard of smoking initiation by age follows an exponential or Weibull model. The log-rank test was used to determine the difference of $H(t)$ in the subgroups. The Proc Lifetest from SAS was used for survival analysis. The life table method was used for the estimation of the hazard of smoking initiation $H(t)$ and the difference in the estimated $H(t)$ between subgroups including sex, ethnicity and residence.

Descriptive analysis techniques and χ^2 test were used in the study. Demographic characteristics of the study population were presented as percentage. Prevalence of current smoking, lifetime smoking and their 95% CIs were calculated. χ^2 test was used to determine the differences in demographic characteristics and tobacco products use in subgroups. All statistical analyses were performed with SAS Software V.9.2 (SAS Institute, Cary, North Carolina, USA). Two-sided $p < 0.05$ was considered statistically significant.

RESULTS

Demographic characteristics of the participants are summarised in [table 1](#). Of the 4801 participants, 1940 were men (40.4%) and 2861 were women (59.6%). Among the participants, 38.8% were from ethnic minority and 70.2% were rural residents. No sex differences were

found in ethnicity, residence and income. Men were more educated than women ($p < 0.05$).

[Table 2](#) shows the current and lifetime smoking prevalence (95% CI) of the participants. The prevalence rates of current and lifetime smoking for men (60.4% and 66.2%, respectively) were significantly higher than those of women (7.0% and 5.1%, respectively). Education and income were negatively associated with prevalence of tobacco smoking. Smoking was particularly more prevalent among rural and ethnic minority women.

[Table 3](#) summarises the three types of tobacco products used by the participants. Overall, 80.7% of the participants smoked cigarettes, 10.8% smoked pipe tobacco and 8.5% smoked waterpipe. There was significant sex, rural-urban and ethnic difference in smoking patterns. Men, urban residents and Han Chinese were more likely to smoke cigarettes while others more likely to smoke pipe or waterpipe tobacco.

Results from survival analysis indicated a satisfactory data-model fit. The plots of $-\log(S(t))$ over age showed a curved line overall and for subgroups by sex, ethnicity and residence. And the plots of $\log\{-\log(S(t))\}$ against $\log(\text{age})$ showed a roughly straight line that passed through the origin overall and for each of the six subgroups. These results indicated that the hazard of smoking initiation for the participants follows a Weibull distribution.

[Figure 1](#) presents the estimated hazards of smoking initiation by age using the survival model: (A) for overall sample and (B) by sex. The youngest age of initiation of smoking was 5 years. Before the age of 12 years, the

Table 2 Prevalence and 95% CI of current and lifetime smoking (n=4801)

Variable	Men		Women	
	Current smoking % (95% CI)	Lifetime smoking % (95% CI)	Current smoking % (95% CI)	Lifetime smoking % (95% CI)
Age in years				
15~24	27.4 (21.4 to 33.4)	32.1 (25.8 to 38.4)	0.6 (0 to 1.1)	3.3 (1.4 to 5.2)
25~44	64.4 (61.1 to 67.8)	68.8 (65.6 to 72.1)	5.1 (3.9 to 6.4)	6.7 (5.4 to 8.0)
45~65	64.6 (61.6 to 67.7)	71.7 (68.8 to 74.6)	6.2 (4.9 to 7.6)	8.2 (6.7 to 9.2)
Residence				
Urban	63.0 (58.9 to 67.0)	70.6 (66.9 to 74.3)	1.2 (0.4 to 1.8)	3.6 (2.3 to 4.8)
Rural	59.4 (56.8 to 62.0)	64.4 (61.9 to 66.8)	6.8 (5.7 to 7.9)	8.5 (7.2 to 9.7)
Ethnicity				
Han	60.5 (57.7 to 63.2)	67.3 (64.6 to 70.0)	0.9 (0.4 to 1.4)	2.9 (2.1 to 3.7)
Minority	60.4 (56.9 to 63.9)	64.4 (60.8 to 67.8)	11.5 (9.6 to 13.3)	13.2 (11.2 to 15.2)
Household income (¥)				
<5000	66.9 (62.8 to 70.8)	72.0 (68.2 to 75.8)	7.1 (5.3 to 8.2)	8.7 (6.7 to 10.6)
5000 ~	58.7 (55.7 to 61.6)	64.2 (61.4 to 67.1)	5.1 (4.0 to 6.1)	7.2 (5.9 to 8.4)
≥20000	53.0 (46.4 to 59.4)	60.3 (55.0 to 66.6)	2.1 (0.8 to 3.6)	3.6 (1.6 to 5.6)
Educational attainment				
Primary school or less	65.5 (62.4 to 68.6)	70.5 (67.5 to 73.5)	8.1 (6.8 to 9.6)	9.6 (8.2 to 11.1)
Secondary school	56.3 (52.7 to 60.0)	62.4 (58.8 to 66.0)	0.6 (0.1 to 1.1)	3.0 (1.8 to 4.2)
High school or more	55.5 (50.1 to 60.8)	62.5 (57.1 to 67.8)	2.1 (0.7 to 3.5)	4.5 (2.5 to 6.4)
Total	60.4 (58.2 to 62.6)	66.2 (64.1 to 68.7)	5.1 (4.3 to 5.9)	7.0 (6.0 to 7.9)

estimated hazards of smoking initiation among men and women were rather low (less than 0.5% and 0.05%, respectively). However, from 12 years of age, the hazards began to increase in men and women. From 15 years of age, the increases in hazards accelerated and peaked at age 19 years for men (21.5%) and women (1%). After 19 years of age, the hazards declined rapidly for both men and women. The log-rank test indicated significant sex differences in the estimated hazards of smoking initiation ($\chi^2=2045.8$, $p<0.01$).

Figure 2 compares the hazards of smoking initiation by age in men between urban and rural residence (A) and

between Han Chinese and ethnic minority (B). The age patterns of the estimated hazards of smoking initiation for rural and urban residents and between Han Chinese and ethnic minority were similar to that of the overall pattern as presented in figure 1. Both the rural-urban and ethnic differences were not statistically significant ($\chi^2=0.13$, $p=0.71$; $\chi^2=0.83$, $p=0.36$).

Figure 3 shows urban-rural (A) and Han minority (B) differences of women in the estimated hazards of smoking initiation by age. Figure 3(A) indicated a significantly higher hazard of smoking initiation for rural women than urban women during the age range 15–19 years. Overall

Table 3 Tobacco products used by the current smokers (n=1317)

	N	Tobacco products			χ^2	P values
		Cigarette n (%)	Pipe tobacco n (%)	Waterpipe n (%)		
Sex						
Men	1172	1012 (86.3)	77 (6.6)	83 (7.1)	7.7	<0.01
Women	145	51 (35.2)	62 (42.8)	32 (22.1)		
Residence						
Urban	360	331 (91.9)	11 (3.1)	18 (5.0)	10.3	<0.01
Rural	957	732 (76.5)	128 (13.4)	97 (10.1)		
Ethnicity						
Han	744	653 (87.8)	33 (4.4)	58 (7.8)	29.2	<0.01
Minority	573	410 (71.6)	106 (18.5)	57 (9.9)		
Total	1317	1063 (80.7)	139 (10.6)	115 (8.7)		

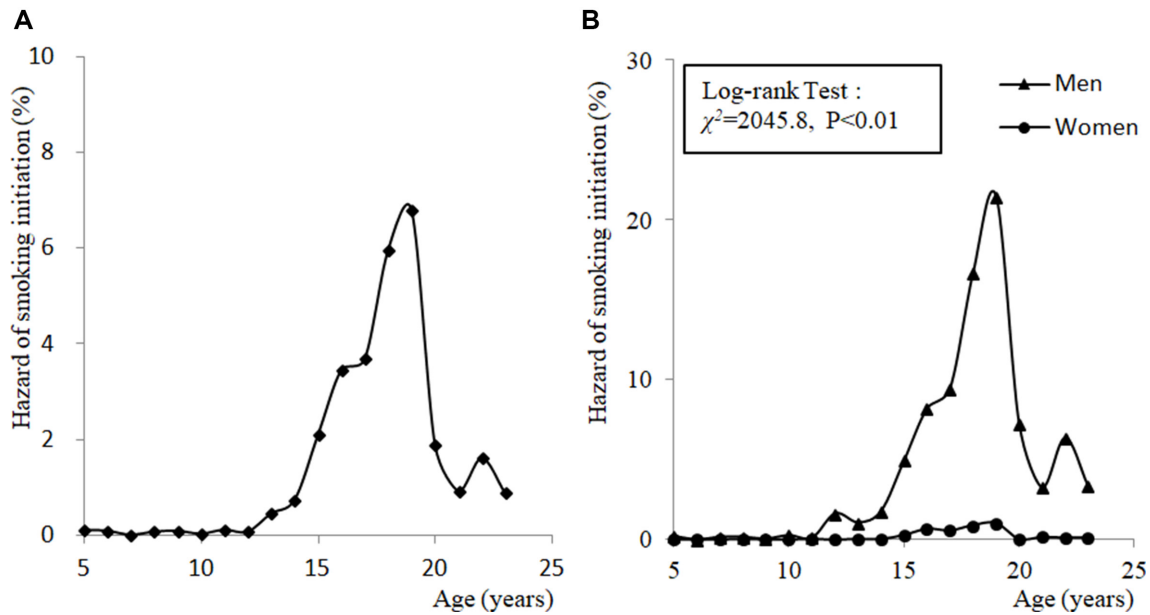


Figure 1 Estimated hazards of smoking initiation by age: (A) overall sample, (B) by sex.

the urban-rural difference was statistically significant ($\chi^2=44.8$, $p<0.01$). **Figure 3(B)** showed that the hazards of smoking initiation were much higher for ethnic minority women than Han Chinese women also during the age range 15–19 years. From age 20 years, the hazards maintained at a very low level for Han Chinese women but increased suddenly for ethnic minority women. The difference was statistically significant ($\chi^2=165.2$, $p<0.01$).

DISCUSSIONS

The main findings of this study can be summarised as follows. First, smoking was highly prevalent among men in South-West China. Second, there was a significant difference in the type of tobacco products used depending on their sex, residence and ethnicity. Finally, the hazard of

smoking initiation sharply increased among men and women when they were 15–19 years old.

In this study, the overall prevalences of current smoking for men and women are 60.4% and 5.1%, respectively, which is significantly higher than the national average (51.6% and 2.9% for men and women, respectively).⁴ A recent study in South-West China indicates that smoking and passive smoking account for 13.1% of local direct and indirect health costs.²⁵ This situation calls for immediate preventive measures that aim towards tobacco control in South-West China. In terms of social determinants of smoking, our findings that men and women with lower education and income are more likely to smoke are consistent with previous findings from studies conducted in China and other developing countries.^{26,27} The current

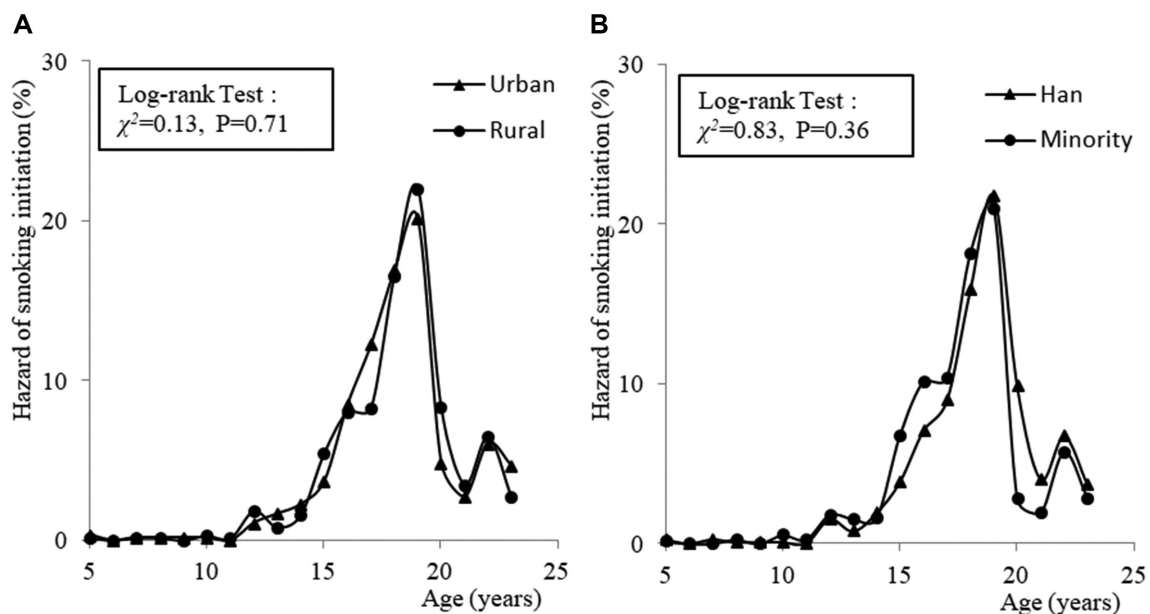


Figure 2 Estimated hazards of smoking initiation by age in men: (A) by residence, (B) by ethnicity.

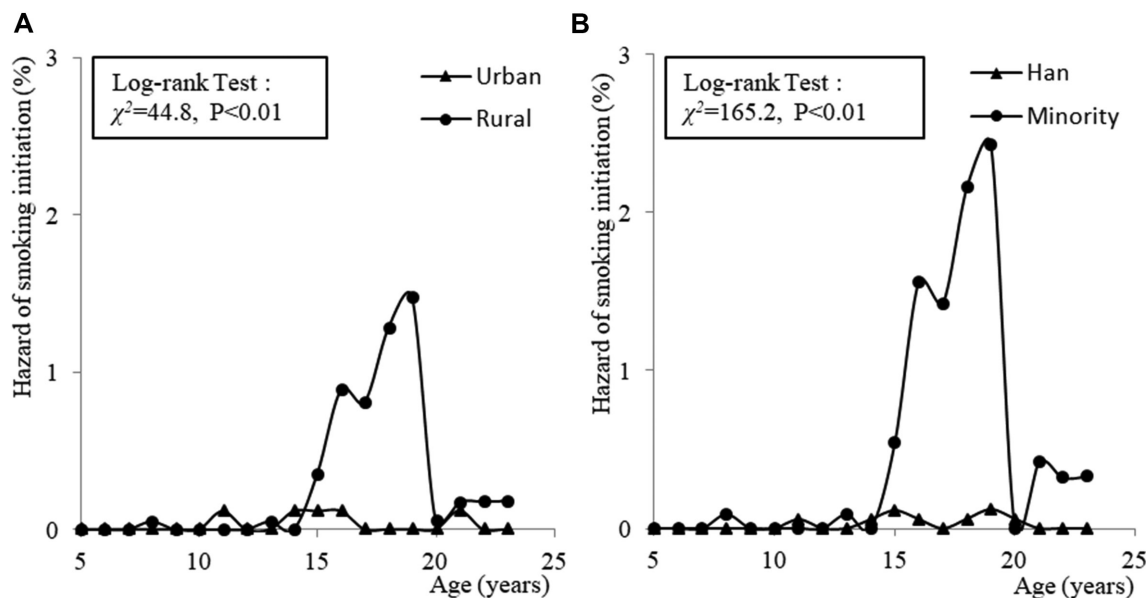


Figure 3 Estimated hazards of smoking initiation by age in women: (A) by residence, (B) by ethnicity.

analysis does not show any significant association between smoking and place of residence or ethnicity among men. However, smoking prevalence was found to be significantly higher among rural (6.8%) and ethnic minority women (11.5%) as compared with urban (1.2%) and Chinese Han women (0.9%). One possible reason for the differences could be low educational status and lesser awareness regarding the health risks of tobacco smoking among the rural and minority women in South-West China.^{7 28} Another reason could be the cultural approval and the acceptance of women's smoking among many ethnic minorities in South-West China.²⁹ For example, an earlier study found that smoking prevalence among Dai ethnic women was 5.0% which is close to the current findings.³⁰ Finally, the high smoking prevalence among women in this study compared with other studies from South-West China (1.3%–1.4%)^{31 32} may also be due to the higher proportion of ethnic minority participants included in this study (39.4% vs 23.8%). The above findings highlight an urgent need to develop and implement women-specific smoking prevention strategies in South-West China.

In line with previous studies from China,^{31 33} we also found significant differences in the pattern and type of tobacco use by sex, residence and ethnicity. In this study, cigarette is the most popular form of tobacco smoking for men (86.3%), whereas pipe tobacco is the most popular form among women (42.8%). Rural and minority residents are more likely to use pipe tobacco and waterpipe compared with their urban counterparts. There are several reasons for these differences. First of all, people living in Yunnan Province, situated in rural South-West China, have easier access to tobacco products since tobacco is the main cultivation in most of the counties of Yunnan Province contributing to 40% of the tobacco production in the China.³⁴ Second, pipe tobacco and waterpipe are cheaper compared with cigarettes in areas where tobacco

is cultivated, making it a preferred product for the rural population.³⁵ Additionally, women usually smoke in their own private circles making it easier to use a waterpipe or pipe tobacco than cigarettes.³⁶ However, waterpipe and pipe tobacco contain many of the same toxicants as cigarette, and also have substantial health risks.^{37 38} Therefore, tobacco control policies need to seriously consider the health risks of using diverse tobacco products and also curtailing the tobacco cultivation in South-West China.

In this study, we identified a peak of smoking initiation from 15 years to 19 years of age, as well as a significant sex difference in the age pattern of smoking initiation similar to the study conducted by Chen *et al* in another city located in central China.¹⁴ Studies have reported that in USA the hazards of smoking initiation peak during the mid-teens (15–16 years old), and there is no significant difference in sex.^{11 24} Our findings indicate that men are still the key focus of tobacco control in South-West China, and the relative low hazards of smoking initiation in women should be maintained or decreased. In addition, we found that rural and ethnic minority women were at higher risk of smoking initiation. Yet, a larger examination of the policies and regulations in China has paid little attention to tobacco control in these populations.^{39 40} Previous studies have shown that the determinants of youth smoking range from individual-level factors to broad social influence.^{41–43} The sharp increase of smoking initiation from 15 years of age may be partly explained due to imbalance between physical maturation and cognitive development.⁴⁴ The imbalance many times encourages adolescents to experiment on various risky behaviours such as smoking, to appear grown-up, 'cool' and gain peer acceptance.⁴⁵ Further, 15–19-year-old adolescents are under great pressure from school and family, and they may start using smoking as a method to cope with negative emotions.⁴¹ Lastly, older adolescents usually have easier access to tobacco products

than younger adolescents, which is a prerequisite for smoking.⁴⁶

A study conducted in USA showed that a 1-year delay in the age of smoking initiation predicted about 0.7 times less likelihood of being a regular smoker.⁴⁷ Thus, preventing adolescents from taking the first puff is a significant step to achieve reduction of tobacco use among the adult population in the future.³ Additionally, existing tobacco control strategies should be implemented more effectively. For example, although tobacco sales have been banned in China since 1999, further actions are urgently needed to effectively enforce the ban regulations to reduce the accessibility of cigarettes to adolescents.⁴⁸ Second, extending and enforcing smoke-free places, have been associated with lower rates of adolescents smoking.⁴⁹ Third, enforce comprehensive bans on all tobacco advertising and educate adolescents that smoking is not a symbol of ‘handsome’ or independence, but a serious addiction and health risk. Information on the health risks associated with pipe tobacco and waterpipes that are being widely used in South-West China should be disseminated and special emphasis should be given on this issue in local health education. Finally, given the long-standing hazards and complex determinants of smoking initiation, effective interventions for adolescents and young adults should begin from senior elementary school and continue throughout their college life.^{42–50}

There are several limitations to this study. First of all, the findings reported here are based on a cross-sectional data set with limited ability to determine causal relationships. The age of smoking initiation is based on self-reports, and may therefore be subject to recall bias. Lack of validation of smoking status with nicotine testing may underestimate the prevalence of smoking. Further, since the present findings were based on a random sample from six counties in South-West China, caution is needed to generalise the results to other places within China.

The findings of this study provide important information on the patterns of smoking behaviours among adolescents and young adults which could serve as the foundation to develop and implement effective smoking prevention intervention programmes. Additionally, our study findings highlight the significance of pipe tobacco and waterpipes among women in certain parts of China, thereby pointing to an urgent need for gender-specific education and prevention policies to control the use of these products in those areas.

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Competing interests None declared.

Patient consent Obtained.

Ethics approval The Institutional Review Board at the Chinese Center for Disease Control and Prevention.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement For access to the data set, please contact the lead author (counterstriker_zq@163.com).

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