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ORIGINAL ARTICLE

Decreased smoking initiation among male youths in China: an urban–rural comparison

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Abstract
Objectives This study compared urban/rural differences in smoking initiation during the transition from adolescence to young adulthood among Chinese males.
Methods Data were derived from the China Health and Nutrition Survey ($N = 2395$). Logistic and cox models were computed to assess smoking initiation between the ages of 15 and 20 across urban/rural administrative districts (i.e. urban neighborhood, suburban village, county town neighborhood, and rural village).
Results Findings revealed that rates of smoking initiation decreased from the 1970 to 1996 cohorts in all four administrative districts. After adjusting for household and community characteristics, the inverse association between smoking initiation and birth year remained statistically significant ($p < 0.05$) in all administrative districts with the exception of urban neighborhoods. County town neighborhoods and suburban villages witnessed accelerated reductions in smoking initiation.
Conclusions Decreased smoking initiation appears to be associated with birth year, which may be correlated with social and economic development of China in conjunction with an unprecedented rate of urbanization. Results suggest that the rate of smoking initiation for male youths may experience further decreases, particularly in areas with a heightened potential of urbanization.

Keywords Adolescent · China · Cigarette · Smoke · Smoking initiation · Tobacco · Young adulthood · Youth

Introduction

China contains nearly one-third of the world's smokers. Data indicate that more than 350 million individuals in China regularly smoke cigarettes (Hu 2007). Smoking contributes heavily to China's burden of disease and costs more than $5 billion each year (Bekedam 2007). Extensive research has been conducted to understand the prevalence (Weng et al. 1987; Yang 2007; Yang et al. 1999), risk factors (Hesketh et al. 2001; Wang et al. 1994; Wen et al. 2007), health consequences (Gan et al. 2007; Liu et al. 1998; Masood et al. 2015; Zhang and Ratcliffe 1993), and economic burden (Hu and Tsai 2000; Sung et al. 2007; Yao et al. 2014) of smoking in China. For example, research indicates that the prevalence of smoking among males has remained at or above 60 % between 1984 and 2002 (Gu et al. 2004; Yang 2007; Yang et al. 1999) and decreased to 53 % in 2010 (Li et al. 2011). Approximately two-thirds of Chinese males become daily smokers prior to age 25 (Yang

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et al. 1999). Risk factors associated with probability of smoking in Chinese samples include gender, marital status, socioeconomic background, employment status and occupations, exposure to tobacco advertisement, smoking behaviors of family members and peers, and household smoking restrictions (Pan and Hu 2008; Wen et al. 2007; Yang et al. 2012, 2015).

Since smoking behavior is highly correlated with family and geographic socioeconomic status, lifetime smoker rates were much higher in rural than in urban China (Li et al. 2011; Kenkel et al. 2009; Wang et al. 2014). For example, for adolescents surveyed in seven Chinese cities, Ma et al. (2008) found that rural boys had both lifetime and current smoking rates statistically higher than urban boys. The high smoking rate in rural region is likely to be associated with its less-developed socioeconomic conditions. The economic inequality between rural and urban China has been extensively reported in previous research and attributed to government's development strategy on industrialization in urban regions (e.g. Yang 2002). As the outstanding characteristic of Chinese society, the urban–rural divide may be reflected in different smoking behaviors of urban and rural residents. The importance of the urban–rural context as a determinant of individual smoking behavior has been examined in other countries as well (e.g. Griffin et al. 2015).

Despite these findings discussed above and new research on adolescents' smoking behavior since the 1990s (Hesketh et al. 2001; Weiss et al. 2006; Wen et al. 2007), few studies have specifically examined the trends and changes in smoking initiation during the transition from adolescence to young adulthood in China. The transition from adolescence to young adulthood represents a critical time for risk-taking behaviors such as smoking (Edwards et al. 2013; Freedman et al. 2012; Lantz 2003; O'Loughlin et al. 2014). One smoking prevalence study showed the age of smoking initiation for males in China dropped from age 23 in 1984 to age 17 in 2002 (Yang 2007). Our own analysis of the data from the China Health and Nutrition Survey (CHNS) shows that, among males who ever smoked, the majority—more than 70 %—initiated smoking between age 15 and 20, and, once initiated, more than 95 % became regular smokers over time. This preliminary analysis demonstrates the importance of understanding smoking initiation behavior and its risk factors in the transition from adolescence to young adulthood. The prevention of smoking initiation during these critical years is likely to have substantive impacts on tobacco control. As such, the primary aim of the present study is to explore changes in smoking initiation between the ages of 15 and 20 for males over multiple birth cohorts in China. Females were not included in our analyses due to a low rate of smoking (less than 4 % for women above 15 years) (Hu 2007). Given the urban–rural patterns identified in previous studies (Kenkel et al. 2009; Li et al. 2011; Wang et al. 2014), we paid attention to the urban–rural comparisons throughout our analyses.

Methods

Data and sample

The study employed longitudinal data from the CHNS, conducted by the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention. The CHNS used a multistage, random cluster process to draw samples from nine provinces varied substantially in geography, economic development, public resources, and health indicators. Following the same group of households, the first round of the CHNS was conducted in 1989, and eight additional rounds were collected between 1991 and 2011. The CHNS collected detailed information on demographic and socioeconomic background, health, and nutrition from households and their members, and collected information on community infrastructure and services from a knowledgeable community resident.

The CHNS includes about 4400 households, covering some 19,000 individuals. We included the male participant who (1) was interviewed at least once during his age 15–20 (to obtain his demographic information during the transition), and (2) did not initiated smoking before age 15. This selection process generated a sample of 2661 males born between 1970 and 1996. Following exclusion of participants who had missing values on variables listed in Table 1, the final analytic sample is 2395.

Measures

Dependent variable

The CHNS asked participants aged 12 and older whether they had "ever smoked cigarettes". Study participants with positive responses on this question were further asked to provide information on at what age they "started to smoke". For the dependent variable of smoking initiation, we assigned a value of "1" to participants who started to smoke between age 15 and 20, and a value of "0" to those who never smoked cigarettes or started to smoke after age 20. Similar measure of smoking initiation has been used in the previous literature (Breslau et al. 1993; Freedman et al. 2012; Gilman et al. 2009). We adopted this definition for two reasons. As discussed above, the majority of males in China initiated smoking in the period between age 15 and 20. More importantly, different from those initiating smoking in a later age, most individuals between age 15

Table 1 Descriptive statistics of male youths by urban/rural residence (China, Birth Cohort 1979–1996; $N = 2395$)

	Urban neighborhood ($N = 270$)	Suburban village ($N = 411$)	County town neighborhood ($N = 377$)	Rural village ($N = 1337$)
Smoking initiation (yes, %)	26.30	33.09	27.06	39.94
Age of smoking initiation (mean)	17.82	17.59	17.57	17.35
Birth year (mean)	1983	1983	1983	1981
Mother's high school degree (yes, %)	39.63	13.14	22.81	5.24
Annual household income (CNY, mean)	17,348	9187	9890	5301
Father's smoking behavior (yes, %)	47.04	48.66	45.36	51.38
Youth's working status (yes, %)	10.00	19.22	15.38	24.83
Youth's schooling status (yes, %)	62.22	47.45	49.07	41.44
Youth's alcohol drinking (yes, %)	15.56	12.41	7.69	11.37
Community economic activity (mean)	6.14	3.15	5.45	1.81
Community modern market (mean)	6.23	4.99	7.11	3.24
Community housing (mean)	7.70	4.68	5.49	2.40
Community education (mean)	4.32	2.41	3.23	1.95
Community health infrastructure (mean)	7.48	6.77	6.17	4.31

and 20 are likely to be in school (e.g. high school or college students). It provides a unique opportunity for public health practitioners to prevent smoking initiation, such as developing school-based interventions. Our supplemental analysis indicated that those never smoked and those started to smoke after age 20 differed from individuals who started to smoke between age 15 and 20 in a similar way on major independent variables.

Independent variables

The first independent variable is the birth year of participants, ranging from 1970 to 1996 and indicating different birth cohorts. The second one is a four-category indicator of urban/rural residence. The CHNS collected information from households living in urban or rural areas. According to the administrative district where households resided, participants in urban areas were further categorized into those living in "urban neighborhood" or "suburban village", and households in rural areas were categorized into those living in "county town neighborhood" or "rural village". These four categories represent different levels of urbanization and concentration of administrative and socioeconomic resources: urban neighborhoods generally have the highest level of urbanization, followed by county town neighborhoods and suburban villages, and rural villages have the lowest level.

Covariates

The analyses adjusted for three groups of important covariates. All information on covariates were extracted from participants' first interview between age 15 and 20. The first group is household and parental characteristics, including mother's education (1 = high school or above, and 0 = below high school), log-transformed household income, and whether the father of a male youth is a smoker or not (1 = Yes, and 0 = No). The second group has three indicators of youths' characteristics—working status (1 = Yes, and 0 = No), schooling status (1 = in school, and 0 = not in school), and alcohol drinking behavior (1 = Yes, and 0 = No). Participants were asked whether they drank "beer or any other alcoholic beverage" in the year when the interview was conducted.

In addition, we controlled for five indicators of the urbanization components generated by the CHNS (Jones-Smith and Popkin 2010). To define the level of urbanization for communities included in the survey, the CHNS created 12 indicators to reflect different dimensions of urbanization. Since these 12 indicators are highly correlated, we added only five of them in our analyses—economic activity, modern markets, housing status, education, and health infrastructure—assuming that these indicators are likely to be associated with youths' smoking behavior. Economic activity is indicated by typical daily wage for ordinary male worker and percent of nonagricultural workers in the population. Modern markets are generated from the number of supermarkets, cafes, internet cafes, indoor restaurants, and so on, within the community. Housing status indicates the availability of electricity, indoor tap water, flush toilets, and gas. Education is defined by the average education level among adults older than 21 years. Health infrastructure counts the number of health facilities and pharmacies in or nearby the community.

Using a specifically designed scoring algorithm, the CHNS assigned a value from 0 to 10 to each of these indicators, with a greater value indicating a higher level of urbanization.

Analyses

We conducted four sets of logistic regressions in a hierarchical process, and compared the trend of smoking initiation over birth cohorts by urban/rural residence. The first set of logistic regression used the birth year as the only independent variable, the second one added household and parental characteristics, the third one added youths' characteristics, and the final one further included urbanization indicators of the community.

One potential limitation of these analyses is that a small proportion of youths (those born after 1991) had not reached age 20 at the last round of the CHNS interview. We therefore conducted cox regression analyses by urban/rural residence in one set of supplemental analyses. In addition, the cut-off age of 20 years for smoking initiation in our main analyses may appear arbitrary, however, we chose this because the smoking initiation rate decreased dramatically after age 20 in the sample. We assessed this decision further in a second set of supplemental analyses which expanded the cut-off age to 22 (i.e. the typical age for college graduation) and 25, respectively. As discussed above, 266 participants were excluded from our analyses due to missing information. Among these participants, 250 had missing values on the variable of mother's education. The analysis shows that participants with missing information on mother's education differed from those without missing information on multiple variables, including children's schooling status and alcohol drinking behavior, and urbanization indicators. In the third set of supplemental analyses, we categorized mother's education into three groups (2 = missing, 1 = high school or above, and 0 = below high school), and generated a sample of 2641. Results for this sample are consistent with those from the main analyses proposed above.

Results

Descriptive statistics

Table 1 reports descriptive statistics by urban/rural residence. All demographic and socioeconomic characteristics were aggregated through multiple cohorts within each type of administrative districts. The mean birth year was 1981 for male youths living in rural villages and 1983 for those living in other three types of administrative districts. The average rate of smoking initiation between age 15 and 20 was lowest in urban neighborhoods (26 %), and highest in rural villages (40 %); it was 27 and 33 % for county town neighborhoods and suburban villages, respectively. Among males who started smoking between age 15 and 20, the mean age of smoking initiation was less than 18 years old.

As demonstrated by five urbanization indicators, urban neighborhoods had the highest level of urbanization, followed by county town neighborhoods and suburban villages, while rural villages had the lowest level of urbanization. Similar to the pattern shown on urbanization indicators, mothers in urban neighborhoods had a highest rate of high school graduation (40 %), and those in rural villages had the lowest one (5 %). Annual mean household income was as follows: Urban (CNY17,348), county town (CNY9,890), suburban (CNY9,187), and rural villages (CNY5,301). Across the four types of administrative districts, nearly half of fathers of these male youths were cigarette smokers. Youths were more likely to be working and less likely to be students in rural areas than urban areas. Less than 20 % of male youths reported alcohol drinking experiences in the previous year.

Figure 1 presents smoking initiation rates by birth cohort and urban/rural residence. The rates decreased continuously in four administrative districts from the 1970 to 1996 cohorts. The rates for those born after 1991 in this figure are underestimated because they have not reached age 20 yet in the last round of the CHNS in 2011. Smoking initiation in urban neighborhoods (the solid line) decreased from about 50 % to less than 30 % between the 1970 and 1990 cohorts. In county town neighborhoods (the dash line), male youths in the 1970 cohort had a smoking initiation rate of 70 % while the rate was less than 20 % for the 1990 cohort. The long dash line indicates that the rate in suburban villages reduced by about 60 % points from

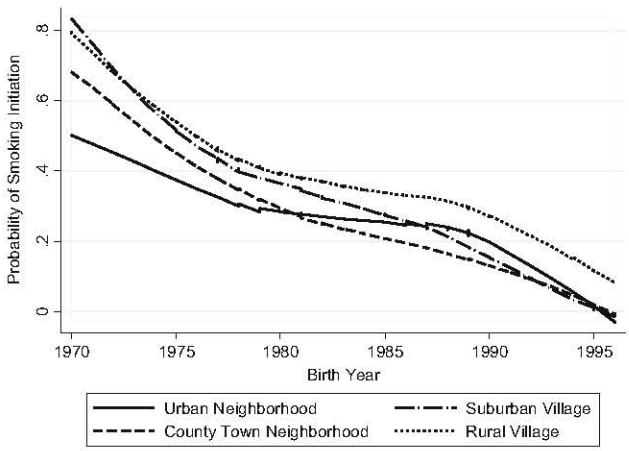

Fig. 1 Probability of smoking initiation between age 15 and 20 by birth year and urban/rural residence (China, Birth Cohort 1979–1996; $N = 2395$). Birth cohorts 1992–1996 have not reached age 20 at the last round interview (2011) of the China Health and Nutrition Survey

about 80 % to less than 20 % across these birth cohorts. A similar trend can be found for those living in rural neighborhoods (the dot line): the rates were about 80 and 30 % for the 1970 and 1990 cohorts. Compared to urban neighborhoods, two lines for county town neighborhoods and suburban villages have steeper slopes and reach lower points for cohorts born after 1980 and 1986, respectively. Smoking initiation rates decreased faster in county town neighborhoods and suburban villages.

Regression results

The first Panel in Table 2 displays four sets of logistic regressions by the type of administrative districts. In the first set of analyses (Model 1), the only independent variable, birth year, is negatively associated with the likelihood of smoking initiation in all four types of administrative districts ($p < 0.001$). In urban neighborhoods, the odds ratio for smoking initiation between a cohort and its previous cohort is 0.93 (95 % CI: 0.89, 0.97); every 1 year increase in the birth year reduces the probability of smoking initiation by 1.4 percentage points. The odds ratio for smoking initiation between a cohort and its previous one is 0.88 ($p < 0.001$) in county town neighborhoods and suburban villages, and the marginal effect is about 2.3 percentage points. Similar, this odds ratio in rural neighborhoods is 0.91 (95 % CI: 0.89, 0.93), with a marginal effect of 2.0 percentage points. We used a Chi-square test to compare the association between birth year and smoking initiation in urban neighborhoods with associations in other types of administrative districts. Consistent with findings in Fig. 1, associations in county town neighborhoods and suburban villages are statistically greater than that in urban neighborhoods ($p < 0.05$), indicating a faster decrease in smoking initiation.

The inclusion of household socioeconomic indicators in the second logistic regression (Model 2) did not change the results on the birth year variable statistically. Mothers' education is negatively associated with smoking initiation for male youths in rural villages (OR = 0.54; 95 % CI: 0.29, 0.99), but this association is only marginally statistically significant at the 0.10 level for those in urban neighborhoods.

After adding youths' characteristics in the third set of analyses (Model 3), the association between smoking initiation and the birth year in urban neighborhoods becomes nonsignificant, and youths' student status plays a significant role in reducing the risk of smoking initiation (OR: 0.32; 95 % CI: 0.17, 0.62). For male residents in suburban villages, the odds ratio for smoking initiation between one cohort and its previous cohort increases from 0.88 in previous analyses to 0.91 (95 % CI: 0.88, 0.95), and is not statistically different from that of urban neighborhoods. Male youths in suburban villages who had been working were also more likely to initiate smoking relative to their counterparts (OR: 2.26; 95 % CI: 1.16, 4.39). In county town neighborhoods, the odds ratio of smoking initiation between one cohort and its previous cohort is 0.89 (95 % CI: 0.85, 0.93), and is still statistically different from that in urban neighborhoods. Model 3 for rural villages identifies several significant predictors, including mother's education, household income, youths' birth year, working status, and alcohol drinking behavior.

The final set of analyses (Model 4) included five urbanization indicators. Among these urbanization indicators, health infrastructure is negatively associated with smoking initiation in urban neighborhoods (OR: 0.76; 95 % CI: 0.59, 0.98); economic activity (OR: 0.87; 95 % CI: 0.80, 0.95) and education (OR: 0.81; 95 % CI: 0.66, 0.99) are negatively correlated with the dependent variable in rural village. Youths' birth year has negative association ($p < 0.001$) with smoking initiation within all types of administrative districts except urban neighborhoods; however, the association is not statistically different from each other across four administrative districts. The marginal effect of the birth year variable is 1.7 percentage points, 1.4 percentage points, and 1.0 percentage point, respectively, for youths living in suburban villages, county town neighborhoods, and rural villages.

Cox regression results are presented in the second panel of Table 2 and overall are similar to those from the logistic regression models. Figure 2 present the trends of smoking initiation in an extended age range (age 15–22) across birth cohorts as an example of the second sensitivity test.

Discussion

A major driver of the burden of chronic disease in China is smoking and Chinese males account for the lion's share of it. We sought to uncover changes in smoking initiation between the ages of 15 and 20 for males over multiple birth cohorts and across the urban–rural continuum. Findings suggest that smoking initiation between age 15 and 20 decreases substantially across cohorts and different types of administrative districts (Fig. 1; Table 2). With minor differences, a similar trend is identified when we extended the range to age 22 or age 25 (e.g. Fig. 2). Change in smoking initiation from the 1970 to 1996 cohorts might contribute to the recent reduction in the current smoking rates for males in China (Li et al. 2011). The consistent changes of smoking initiation across different administrative districts suggest that this decrease is not likely to have been caused by any specific tobacco control interventions or policies. There is no tobacco control intervention being implemented in such broad areas, and no national tobacco

Table 2 Regression results: predicating the probability of smoking initiation using birth year (China, Birth Cohort 1979–1996; $N = 2395$)

Logistic regression:	Urban neighborhood ($N = 270$) OR (95 % CI)	Suburban village ($N = 411$) OR (95 % CI)	County town neighborhood ($N = 377$) OR (95 % CI)	Rural village ($N = 1337$) OR (95 % CI)
Model 1				
Birth year	0.93*** (0.89, 0.97)	0.88***,a (0.85, 0.91)	0.88***,a (0.84, 0.91)	0.91*** (0.89, 0.93)
Model 2				
Birth year	0.94** (0.90, 0.99)	0.88***,a (0.85, 0.92)	0.88***,a (0.85, 0.92)	0.91*** (0.90, 0.93)
Mother's high school degree	0.55ψ (0.29, 1.04)	0.62 (0.29, 1.32)	0.95 (0.48, 1.85)	0.54* (0.29, 0.99)
Log-transformed household income	0.89 (0.70, 1.14)	1.14 (0.93, 1.41)	0.88 (0.73, 1.05)	0.91ψ (0.83, 1.00)
Father's smoking behavior	1.17 (0.66, 2.08)	1.01 (0.64, 1.58)	1.08 (0.66, 1.77)	1.24ψ (0.98, 1.56)
Model 3				
Birth year	0.95 (0.90, 1.01)	0.91*** (0.88, 0.95)	0.89***,a (0.85, 0.93)	0.94*** (0.92, 0.96)
Mother's high school degree	0.55 (0.29, 1.06)	0.65 (0.30, 1.41)	1.02 (0.52, 2.02)	0.54* (0.29, 0.99)
Log-transformed household income	0.88 (0.68, 1.14)	1.07 (0.88, 1.30)	0.86 (0.71, 1.03)	0.89* (0.81, 0.98)
Father's smoking behavior	1.35 (0.74, 2.48)	1.02 (0.64, 1.62)	1.08 (0.66, 1.78)	1.26 (0.99, 1.61)
Youth's working status	0.91 (0.31, 2.68)	2.26* (1.16, 4.39)	1.23 (0.58, 2.62)	1.53* (1.06, 2.22)
Youth's schooling status	0.32*** (0.17, 0.62)	0.97 (0.58, 1.60)	0.94 (0.54, 1.62)	0.95 (0.71, 1.27)
Youth's alcohol drinking	1.74 (0.79, 3.81)	1.57 (0.78, 3.14)	1.82 (0.76, 4.34)	2.08*** (1.38, 3.14)
Model 4				
Birth year	0.95 (0.89, 1.01)	0.91*** (0.87, 0.95)	0.91*** (0.87, 0.96)	0.95*** (0.92, 0.98)
Mother's high school degree	0.64 (0.32, 1.29)	0.64 (0.29, 1.43)	1.11 (0.53, 2.33)	0.58 (0.31, 1.08)
Log-transformed household income	0.85 (0.63, 1.14)	1.04 (0.84, 1.29)	0.98 (0.78, 1.22)	0.92ψ (0.83, 1.01)
Father's smoking behavior	1.32 (0.71, 2.47)	1.03 (0.64, 1.67)	1.11 (0.66, 1.87)	1.19 (0.93, 1.52)
Youth's working status	0.85 (0.28, 2.60)	2.25* (1.15, 4.43)	1.41 (0.64, 3.10)	1.77** (1.19, 2.63)
Youth's schooling status	0.31*** (0.15, 0.63)	0.99 (0.59, 1.66)	1.04 (0.58, 1.85)	0.99 (0.73, 1.32)
Youth's alcohol drinking	1.97 (0.86, 4.54)	1.51 (0.74, 3.08)	2.06ψ (0.86, 4.98)	2.31*** (1.52, 3.51)
Community economic activity	0.96 (0.83, 1.12)	1.13 (0.98, 1.30)	0.92 (0.78, 1.08)	0.87** (0.80, 0.95)
Community modern market	0.98 (0.86, 1.12)	1.09 (1.00, 1.18)	0.92 (0.83, 1.03)	0.98 (0.94, 1.01)
Community housing	1.10 (0.93, 1.31)	0.87 (0.74, 1.02)	0.90 (0.76, 1.06)	1.06 (0.97, 1.16)
Community education	0.83 (0.64, 1.07)	0.99 (0.74, 1.33)	0.93 (0.63, 1.38)	0.81* (0.66, 0.99)
Community health infrastructure	0.76* (0.59, 0.98)	0.96 (0.84, 1.10)	1.19 (0.97, 1.45)	1.06 (0.98, 1.15)
Cox regression:[c]	HR (95 % CI)	HR (95 % CI)	HR (95 % CI)	HR (95 % CI)
Model 1				
Birth year	0.96* (0.92, 0.99)	0.92***,a (0.89, 0.94)	0.91***,a (0.88, 0.94)	0.94*** (0.93, 0.96)
Model 2				
Birth year	0.97 (0.93, 1.01)	0.92***,a (0.89, 0.95)	0.91***,a (0.88, 0.94)	0.95*** (0.93, 0.96)
Model 3				
Birth year	0.99 (0.95, 1.04)	0.95**,b (0.92, 0.98)	0.91***,a (0.88, 0.95)	0.97** (0.95, 0.99)
Model 4				
Birth year	0.99 (0.94, 1.04)	0.95** (0.91, 0.98)	0.93**,b (0.89, 0.97)	0.98* (0.96, 0.99)

OR odds ratio, *HR* hazard ratio

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ψ $p < 0.10$

[a] The association between birth year and smoking initiation in this column is statistically different from that in the first column (i.e. urban neighborhood) at the 0.05 level

[b] The association between birth year and smoking initiation in this column is statistically different from that in the first column (i.e. urban neighborhood) at the 0.10 level

[c] Model specifications for cox regressions are the same as those of logistic regression. However, we do not report the results on control variables in cox regression analyses

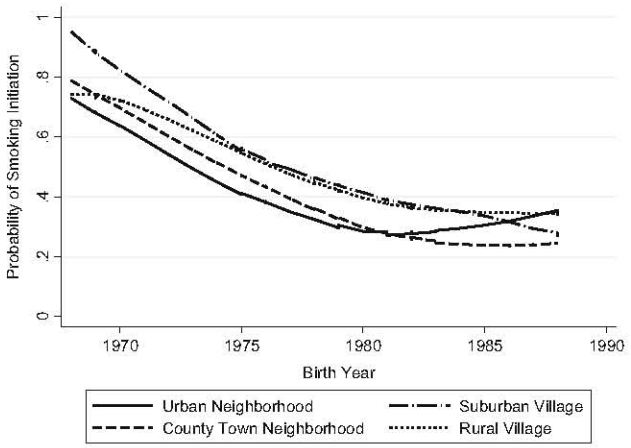

Fig. 2 Probability of smoking initiation between age 15 and 22 by birth year and urban/rural residence (China, Birth Cohort 1968–1988; $N = 2791$)

control policy lasting in such a long period of time. Several tobacco control policies were initiated and established during this period; however, there has been a lack of compliance with these policies (Hu 2007). The consistent decrease across different types of administrative districts is also less likely to be caused by factors such as cigarette price change and pro-tobacco marketing. These factors may have various effects on urban and rural residents given their socioeconomic status. One possible mechanism fueling this decrease in smoking initiation may be the social and economic development of China that has occurred in last three decades.

Our findings also suggest that lower smoking initiation rates are associated with higher levels of urbanization, particularly for earlier birth cohorts included in the study. For example, the smoking initiation rate for the 1970 birth cohort is 20 % points lower in urban neighborhoods than in other administrative types. Our findings further demonstrate a different rate of reduction in smoking initiation between urban neighborhoods and county town neighborhoods, and between urban neighborhoods and suburban villages. As indicated by the estimated marginal effect of the birth year variable, the predicted reduction of smoking initiation rate in county town neighborhoods and suburban villages is 1 percentage point faster than that in urban neighborhoods.

One possible explanation for the difference in changes of smoking initiation by administrative districts is social and economic development occurring as part of the process of urbanization. After including urbanization indicators in logistic regression models, the association between birth year and smoking initiation in county town neighborhoods was no longer statistically different from that of urban neighborhoods. The difference between urban neighborhoods and suburban villages also becomes nonsignificant after adding urbanization indicators in the cox regression. Most of these urbanization indicators, however, are not statistically significant in analyses probably because of the high correlations among these indicators. The high correlations may lead to a potential multi-collinearity, which would add the difficulty in capturing multiple dimensions of urbanization.

There may be a variety of specific mechanisms by which urbanization could affect smoking initiation in the transition from adolescence to young adulthood. For example, being a student is less likely to expose to a work environment where peers are more likely to smoke. More resources have been invested in the education systems during the urbanization process. The effect of this investment may have reduced the risk of smoking initiation during the transition from adolescence to young adulthood because youths become more likely to stay in school. Since county town neighborhoods and suburban villages had a lower level of urbanization than urban neighborhoods at the beginning of our observations, relatively speaking, they are likely to urbanize at a rate faster and in effect "catch-up" to the levels found in urban neighborhoods. The greater reduction of smoking initiation in these two administrative types could be a reflection of this urbanization process and the attendant macro-level social and economic development that is part and parcel of this process.

Despite the insight generated by the present investigation, there are several limitations that should be noted. First, the CHNS does not cover all provinces, and no weighting scheme is available to generalize the information back to the representative population of China. Second, the sample size by administrative districts is relatively small. For example, the sample size for urban neighborhoods is less than 300, and the reliability of the results could be improved with a larger sample. Third, some potential predictors of smoking initiation for males (e.g. peer pressure and health knowledge on risk behavior) are not included in analyses. The inclusion of additional predictors may better elucidate the trends in smoking initiation over different cohorts and different administrative districts. Finally, for the sake of public health practices in the school context, our definition of smoking initiation focused on the differences between those initiating smoking between age 15 and 20 and others (including both never smokers and late initiators after age 20). Future research should further explore differences among early initiators, late initiators, and never smokers to better understand the smoking initiation process among youth. It is also important to use longitudinal information to examine the dynamics between predictors and youth's smoking imitation, and to test the specific mechanism between urbanization and smoking initiation.

In conclusion, the study observes a decreased smoking initiation between the ages of 15 and 20 for Chinese males from the cohort born in the early 1970s to the cohort born in the late 1990s. Overall, the rate of decrease in smoking initiation is faster in county town neighborhoods and suburban villages. The decreased smoking initiation rate is probably associated with the social and economic development of China that has occurred in last three decades in tandem with the unprecedented rate of urbanization. The National New-type Urbanization Plan was released by the Chinese Central Government in March 2014, setting targets to raising China's urban population by 1 % per year to reach 60 % by 2020. If the current trend holds, it seems reasonable to predict a continuous decrease of smoking initiation for male youths, particularly for those areas with a greater potential of urbanization (e.g. rural village). The rate of reduction in smoking initiation during the transition from adolescence to young adulthood, however, may be relatively flat or even slightly increase for areas with more advantaged levels of urbanization (e.g. the solid line in Fig. 2 for urban neighborhoods). Findings from this exploratory study also suggest that smoking initiation in the transition could be a key leverage point for tobacco control intervention in China; future research should also investigate the association between decreased smoking initiation and the change in the current smoking rate. More restricted tobacco control policies have been established and implemented recently in China. From a public health standpoint, future tobacco control interventions to reduce smoking initiation in China will be more effective if they well suit the situations and needs of youths during the transition from adolescence to young adulthood, particularly in the context of macro social development and urbanization. For example, the 2014 National Global Youth Tobacco Survey indicated that more than half of all students have been exposed to second-hand smoke at school (World Health Organization 2014), and it is urgent to create and implement smoke-free school policies.

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