

RESEARCH ARTICLE

Does retirement affect alcohol expenditure? Evidence from urban Chinese older adults in 2002–2009

Hong Zou¹, Bingjiang Luan¹, Kaizhi Yu², Hongwei Xu^{3*}

¹School of Economics, Southwestern University of Finance and Economics, China,

²School of Statistics, Southwestern University of Finance and Economics, China,

³Institute for Social Research, University of Michigan, United States

Abstract: Exploiting China's mandatory retirement policy, we used fuzzy regression discontinuity design to estimate the effect of retirement on household alcohol expenditure among urban Chinese older adults ages 50–70. Drawing on data from the Urban Household Survey of China Statistics Bureau for the period of 2002–2009, we found that having a retired male household head significantly reduced total household expenditure on alcohol by 32%. After breaking down by different types of alcohol, we found that the retirement effect was largely driven by expenditure on liquor. We explored two potential mechanisms that may explain the retirement effect. The first mechanism relates to decreased disposable income after retirement and the second mechanism involves reduced demand of social drinking after retirement. Our findings suggest that the urban Chinese older adults experience substantial change in such health behavior as drinking as they retire. This has important public policy implications as China is facing a severe challenge of rapid population aging.

Keywords: alcohol expenditure; China; retirement; regression discontinuity design

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*CORRESPONDING AUTHOR

Hongwei Xu
Institute for Social Research,
University of Michigan,
United States.
xuhongw@umich.edu

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1. Introduction

The dramatic increase in the sheer size of older adult population during recent years has created a serious challenge of population aging for China's policymakers. In 2016, about 16.7% of China's population was 60 years and older, 10.8% were above 65 years old, indicating an aging society (Ministry of Civil Affairs of the People's Republic of China, 2017). The World Health Organization (2015) predicted that 28% of China's population would be over 60 years and older by 2040, making it the world's most aging country. The rapid growth of older adult population has attracted new research attention to the impacts of retirement on later life consumption and lifestyle (Li, Shi, and Wu, 2016; Dong and Yang, 2016; Che and Li, 2018).

In China, retirement age is mandatory in the public sectors including the government, public sectors, state-owned enterprises, and collectively-owned enterprises, which together account for a larger share of the national economy than the private sectors. Public sector employees' retirement is regulated by several labor laws initially established in 1950s and revised in subsequent decades, including the Principles of Labor Insurance in 1953, the Temporary Measures on State Employees' Retirement in 1955, the Regulations on Employees' Retirement in 1958, the Temporary Measures on Workers' Retirement and Resignation in 1978, and the Temporary Regulation of Government Employees in 1993. In general, China's retirement policies stipulate that the retirement age is 60 for male employees, 55 for female cadres, and 50 for ordinary female workers. For those who are involved in high-risk or health-damaging jobs, the mandatory retirement age is 55 for men and 45 for women. However, workers can retire earlier before they reach the mandatory

retirement ages under special circumstances. For example, had a worker become disabled due to work-related causes, the mandatory retirement age would be lowered to 50 for men and 45 for women. Workers in state-owned enterprises are allowed to retire before they reach the regular retirement age if their employers declare bankruptcy.

Retirement is an important later life event which affects consumption behaviors and lifestyle, a prominent example being changes in drinking (Eicibh, 2015; Insler, 2014; Zantinge, van den Berge, Smit *et al.*, 2014). Drinking may have beneficial effects such as reducing loneliness, stress, and risk of cardiovascular disease when consumed in small amount (Bamberger, 2015; Ortolá, Garcíaesquinas, and Galán, 2017). However, drinking has been widely considered a risky health behavior and associated with many health problems (Moore, Endo and Carter, 2003; Rehm, Baliunas, Borges *et al.*, 2010; Rehm, Room, Graham *et al.*, 2003). Does retirement affect drinking behavior? Existing studies have produced inconclusive evidence for the impact of retirement on alcohol expenditure (Kuerbis and Sacco, 2012). Some studies found that retirement was associated with decreased alcohol expenditure (Eibich, 2015), while others found that retirement increased alcohol expenditure (Gallo, Bradley, Siegel *et al.*, 2011; Henkens, van Solinge, and Gallo, 2008; Müller and Shaikh, 2016; Perreira and Sloan, 2001; Zins, Guéguen, Kivimaki *et al.*, 2011). Yet other concluded no evidence supporting a causal relationship between retirement and alcohol expenditure (Bacharach, Bamberger, Sonnenstuhl *et al.*, 2004; Behncke, 2012; Oshio and Kan, 2017).

Several mechanisms have been proposed to link retirement to alcohol expenditure. First, alcohol expenditure is closely associated with the amount of economic resources available (Brennan, Schutte, and Moos, 2010; Moos, Schutte, Brennan *et al.*, 2010; Veenstra, Lemmens, Friesema *et al.*, 2006). On the one hand, retirement decreases the labor income of the retiree, which makes alcohol consumption less affordable and, in turn, reduces household expenditure on alcohol. This mechanism may be particularly salient for low-income retirees (Brennan, Schutte, and Moos, 2010). On the other hand, some older adults may increase alcohol expenditure as they resort to drinking to deal with the stress caused by reduced income or social status as a result of retirement (Bamberger, 2015; Bossé, Aldwin, Levenson *et al.*, 1991). In addition, retirement may increase the amount of leisure time available and thus provide more opportunity for drinking (Zins, Guéguen, Kivimaki *et al.*, 2011). Second, to the extent that drinking sometimes serves as a means of social interaction (Gilson, Bryant, Bei *et al.*, 2013; Karen, Paul, and Smith, 2015), older adults may increase or decrease social drinking depending on the change in their social networks after retirement (Bacharach, Bamberger, Cohen *et al.*, 2007; Henkens, van Solinge, and Gallo, 2008; Karen, Paul, and Smith, 2015). Some studies reported that retirement decreased size of the work-related social network and thus discouraged participation in social drinking (Bacharach, Bamberger, Cohen *et al.*, 2007; Mccrady, 2004). Third, drinking may increase after retirement as a way to relax from pre-retirement workplace stressors (Bacharach, Bamberger, Biron *et al.*, 2008; Booth, Curran, and Han, 2004; Zantinge, van den Berg, Smit *et al.*, 2014).

Several limitations persist in the literature. First, some retirement studies did not address the endogenous problem appropriately (Dave, Rashad, and Spasojevic, 2008; Li, Shi, and Wu, 2016) as drinking-related health deterioration may lead to early retirement (Mcgarry, 2004). Second, many existing studies focus on retirement and drinking in developed countries. Little is known about the impact of retirement on alcohol expenditure in China where alcohol drinking traditionally plays an important role in social life but may now impose a public health challenge for the rapidly aging population. Employing a fuzzy regression discontinuity design (RDD), this paper aims to fill the gaps by: (1) Estimating the causal effect of retirement on household expenditure on alcohol among urban Chinese middle-age and older adults and (2) investigating two potential underlying mechanisms - reduced income and reduced social drinking after retirement.

2. Methods

2.1. Study population

We drew on data from the Urban Household Survey (UHS) carried out by China's National Bureau of Statistics. Using a probabilistic sampling and stratified multistage method, the UHS recruited a nationally representative sample of urban households in China. Specifically, the UHS divided urban areas into three strata: Municipal cities, county-level cities, and counties. Within each stratum, a number of counties or cities were randomly selected using a probability proportional to size (PPS) sampling scheme. About two-thirds of all the districts in municipal cities (known as municipal districts) and counties (including county-level cities) in the 31 mainland provinces in China were selected. In each selected municipal district or county, a number of communities were selected using a PPS sampling scheme. In each selected community, about 20–60 households were randomly selected for interview. The National Bureau of Statistics has implemented strict inspection methods to ensure quality data collection and processing. The UHS consist of a rotating panel in which one-third of the sample is replaced each year with a new subsample and the original sample is fully refreshed every 3 years,

making the UHS effectively a repeated cross-sectional survey. In each wave the UHS collects standard demographic information from every member in the family, such as age, gender, marital status, and family composition, as well as rich socioeconomic data on education, income, job history, retirement, consumption, and family expenditure (including the quantity of each item). We obtained the UHS data for the period of 2002–2009 in six provinces and their administrative equivalents (municipalities), ranging from, the most economically developed eastern and southeastern coastal regions (Beijing, Zhejiang, and Guangdong) to the less developed inland region (Sichuan), and from the old industrial region in the northeast (Liaoning) to the ancient cultural and political capital in central China (Shaanxi).

With an average response rate of about 90%, the UHS sampled 31,016 respondents (10,309 households) in 2002; 33,602 respondents (11,352 households) in 2003; 39,681 respondents (13,352 households) in 2004; 45,087 respondents (15,331 households) in 2005; 44,160 respondents (15,140 households) in 2006; 35,630 respondents (11,782 households) in 2007; 35,604 respondents (12,039 households) in 2008; and 34,828 respondents (12,081 households) in 2009. Given that the mandatory retirement policy is only applied in governments, state-owned enterprises, collectively-owned enterprises, and other public sectors, our analytical sample was restricted to respondents who were working or used to work in these four types of institutes. Applying this restriction, our sample sizes were reduced to 16,666 respondents (9,027 households) in 2002; 17,234 respondents (9,615 households) in 2003; 20,370 respondents (11,272 households) in 2004; 22,193 respondents (12,506 households) in 2005; 21,844 respondents (12,332 households) in 2006; 17,904 respondents (9,695 households) in 2007; 15,875 respondents (9,006 households) in 2008; and 15,828 respondents (9,179 households) in 2009.

We dropped 1,897 households that had zero alcohol expenditure because previous research showed that retirement had no effect on alcohol expenditure in older adults without a history of drinking (Zantinge, van den Berg, Smit, *et al.*, 2014). We further restricted the sample to male-headed households and determined the retirement status of households by the retirement status of the male head of households for substantive reasons. First, adult men are the predominant consumers of alcohol in China and the associated household expenditure is likely driven by the male household heads. Second, as mentioned in the introduction section, the retirement policies are gender-biased in China. The official retirement age is 60 years for men, 55 years for female cadres, and 50 years for ordinary female workers. In such case, the early retirement age is 55 years for men and 45 years for women. For the sake of maintaining certain level of household income, women tend to make retirement decisions based on the retirement status of their husbands (Hurd and Rohwedder, 2005). Finally, following the literature that adopts a RDD approach, we restricted the age range of the male household heads to be 50–70 years old; that is, a balanced 20-year bandwidth centered at the official retirement age of 60 years old. The age distribution of male household heads is shown Figure A1 in Appendix. In reality, a 60-year-old man may or may not be retired yet despite the formal policy, so we dropped all households with the male head aged 60 years old. The final analytical sample consisted of 20,776 male older adults aged 50–70 years in total ($n = 2,184$ in 2002; 2,539 in 2003; 2,968 in 2004; 3,295 in 2005; 3,133 in 2006; 2,541 in 2007; 2,056 in 2008; and 2,060 in 2009).

It is worth noting that the head of a household was identified by respondents who chose which household member usually played a decisive role in family affairs. In most cases, a household head was the main contributor to the family's economic condition. It is possible that, among the subsample that was repeatedly interviewed in two or more waves of UHS, a household might switch its head due to changes in each member's economic contribution. Nevertheless, we expect such change to have limited impact on our empirical identification strategy which does not rely on panel data structure.

2.2. Measurements

The main outcome of interest is alcohol expenditure (in Chinese yuan) at the household level, measured as the annual household expenditure on alcohol for the period of 2002–2009. We created separate measures of each household's total expenditure on alcohol and expenditures on different types of alcohol (including liquor, fruit wine, beer, and other types of alcohol). All these dependent variables were approximately normally distributed after log transformation. The key independent variable, retirement status, is a dichotomous variable indicating whether or not the male head of a household was retired at the time of interview. This variable was coded one if the male head of a household was retired at the time of the interview, and zero otherwise.

We control for a set of demographic and socioeconomic variables, including respondents' age (in years), ethnicity, marital status, years of education, and living arrangement. Respondents' age ranges from 50 to 70 years old. Ethnicity and marital status are dichotomous variables. Ethnicity was coded one if the male head of a household was ethnic Han and zero otherwise. Marital status was coded one if the male head of a household was married and zero otherwise (e.g., divorced, separated, widowed, or never married). Years of education referred to the years of formal schooling completed by the male head of a household. Living arrangement was divided into three categories, "living alone,"

“living with spouse only,” and “living with children.” We included dummy variables indexing survey years to control for temporal trends (i.e., period effects). We also included dummy variables for counties and municipal districts to control for geographic variation.

2.3. Analytical strategy

We adopted a fuzzy RDD to estimate the causal effect of retirement on alcohol expenditure. RDD has been widely used to address potential problem of endogeneity in policy evaluations when the eligibility of a subject to receive a treatment (i.e., retirement in this case) depends on whether the value of certain observed characteristic, also known as the running variable (i.e., age), exceeds the cutoff point specified by the policy (i.e., mandatory retirement age). This method alleviates the endogeneity problem due to unobservable variables or reversal causality (Lee and Lemieux, 2010; Li, Shi, and Wu, 2016). RDD provides a way to estimate treatment (i.e., retirement in this study) effects in observational data where treatment is determined by whether an observed “assignment” variable (i.e., age) exceeds a known cutoff point (i.e., mandatory retirement age). The RDD approach allows individuals to have imprecise control over the assignment variable. This feature of RDD is particularly appealing to this study because, as mentioned above, some public sector employees can choose early or delayed retirement under special circumstances. In contrast, an instrumental variable approach requires fully exogenous variation induced by the instrument to assign treatment status.

The validity of our RDD approach requires two assumptions to hold. First, the running variable (age in this case) is unlikely to be manipulated. This assumption likely holds because individuals cannot respond to the mandatory retirement policy by changing their actual ages. Second, there is no discontinuity in the distribution of any other covariate caused by the treatment. In other words, all the control variables take smooth functional forms with respect to retirement status.

Since some employees may retire at an earlier or later age than the mandatory retirement age, our identification strategy should be considered as a fuzzy RDD. Following the practice in the literature (Hahn, Todd, and van der Klaauw, 2001; Li, Shi, and Wu, 2016; Park, Shi, Hseh *et al.*, 2015), our fuzzy RDD specification begins with a regression model as the following:

$$Y_i = \gamma_0 + \gamma_1 R_i + \xi_i, \text{ where } R_i = 1 \text{ if } s_i \geq \bar{S} \quad (1)$$

Where Y_i is household i 's expenditure on alcohol; ξ_i is the error term, and R_i indicates whether the male head of household i is retired ($= 1$) or not ($= 0$). If the mandatory retirement policy is strictly implemented, R_i would be equal to 1 if the male head's age, denoted by s_i , is equal to or above the mandatory retirement age, denoted by \bar{S} ; and 0 otherwise. Since these older adults had essentially the same value of s_i within a small interval around the mandatory retirement age, we can expect similar demographic, socioeconomic, and other unmeasured characteristics on average between older adults who are just below the mandatory retirement age and those who are just above the mandatory retirement age. Therefore, the coefficient γ_1 represents the causal effect of retirement.

Following suggestions by Gelman and Imbens (2018) and Imbens and Lemieux (2008), we used a global high-degree polynomial function to obtain a parametric estimate of γ_1 . When a rectangular kernel is used, the parametric approach is equivalent to estimating the following OLS model:

Where γ_1 represents the treatment effect of interest; and X_i represents a vector of demographic and socioeconomic control variables mentioned above. We included these control variables to ensure the robustness of the results (Frölich and Huber, 2018), despite no such need as suggested in the literature (Lee and Lemieux, 2010; Li, Shi, and Wu, 2016).

The OLS estimate of γ_1 in Equation (2) may be biased if people retire before the mandatory retirement age or continue to work after the mandatory retirement age. We address this problem using a dichotomous instrumental variable, denoted by D_i , to indicate whether a male head's age was above the mandatory retirement age ($= 1$) or not ($= 0$). A household would belong to the treatment group when the male head's age exceeded the mandatory retirement age ($D_i = 1$); and belong to the control group otherwise ($D_i = 0$). We regressed the treatment variable (R_i) on the instrumental variable (D_i) as the following:

We use the two-stage least squares (2SLS) method to fit Equations (2) and (3). We can test the RDD assumption of continuity for covariates by estimating the following model:

$$Y_i = \beta_0 + \beta_1 R_i + \beta_2 (S_i - \bar{S}) + \beta_3 R_i (S_i - \bar{S}) + \beta_4 X_i + \xi_i \quad (2)$$

If β_3 is not statistically significant, the continuity assumption is valid. We test for several predetermined covariates: Ethnicity (Han vs. ethnic minorities), marital status (married or not), years of education. We also tested the continuity assumption for living arrangements, but did not present the results to preserve space.

Table 1. Descriptive statistics of the dependent and independent variables for urban Chinese households with male heads of 50–70 years old: UHS 2002–2009.

Variables	(Ages 50–70)		(Ages 50–59)		(Ages 61–70)		(Ages 61–70)– (Ages 50–59)
	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean difference
Age (years)	58.40	6.02	54.22	2.82	65.15	2.85	10.93***
Retired (%)	46.43		18.27		92.00		
Ethnic han (%)	96.54		96.35		96.85		
Married (%)	98.36		99.03		97.28		
Years of education	11.44	3.25	11.63		11.13	3.46	–0.50***
Living arrangements (%)							
Living alone	0.70		0.45		1.11		
Living with spouse only	41.06		33.54		53.23		
Living with children	58.24		66.01		45.66		
Annual household disposable income (yuan)	35,001	32,358	36,741	37,039	32,169	22,479	–4,572***
Annual expenditure on eating out (yuan)	1,678.72	2,746.60	1,942.61	2,995.78	1,248.01	2,214.00	–694.61***
Total expenditure on alcohol (yuan/year)	299.44	436.16	317.72	484.35	269.86	342.13	–47.86***
Expenditure on liquor (yuan/year)	146.03	311.72	162.43	363.50	119.47	198.66	–42.96***
Expenditure on fruit wine (yuan/year)	31.35	100.37	32.75	103.87	29.08	94.39	–3.67**
Expenditure on beer (yuan/year)	97.27	163.25	99.29	166.99	94.00	156.95	–5.29**
Expenditure on other alcohol (yuan/year)	24.80	122.30	23.25	127.29	27.30	113.71	4.05**
<i>n</i>	20,776		12,841		7,935		

The age group of 50–70 years did not include age 60. UHS: Urban household survey. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$

3. Results

3.1. Descriptive statistics

Table 1 shows descriptive statistics - means (or percentages) and standard deviations - of the dependent and independent variables for the full sample and subsamples. The first column reports the mean and standard deviations for the full sample, that is, households with a male head's aged between 50 and 70 (excluding 60) years old. On average, the respondents in our analytical sample were about 58 years old, completed 11 years of education, and lived in a household of three. Nearly 97% of them were ethnic Han and about 97% were married. The average annual household disposable income was 35005 yuan, and the average total expenditure on alcohol was 299 yuan. The second column reports the descriptive statistics for the subsample in which male household heads aged between 50 and 59 years old. Only about 18% of this subgroup were retired. The third column reports the descriptive statistics for the subsample in which male household heads aged between 61 and 70 years old. More than 90% of this subgroup were retired. The fourth column reports the results of *t*-tests comparing the mean differences in all the variables between the two age subgroups. Overall, the younger age group (50–59 years) enjoyed significantly higher level of annual household disposable income, spent more money on eating out and alcohol but less money on drinking, compared with the older age group (61–70 years).

3.2. First-stage estimation

Figure 1 shows the proportion of retired male respondents in our sample at each age between 50 and 70 years (except 60 years old). Age of the male household head was a strong predictor of his retirement status per visual inspection. Less than 10% of male household heads retired at age 50. The retirement rate gradually increased to 40% at age 59 and jumped up to over 80% at age 61. This sharp discontinuity of retirement rate around age 60 provides descriptive evidence supporting our RDD approach.

The first stage estimation results of the 2SLS (i.e., Equation 3) shown in Table 2 confirm the graphical findings. After controlling for other variables, year, county/district fixed effects, a male household head being above 60 years old predicted a significantly higher probability of being retired ($\beta = 0.40$). *F*-test value was 884.61, considerably > 10 , the

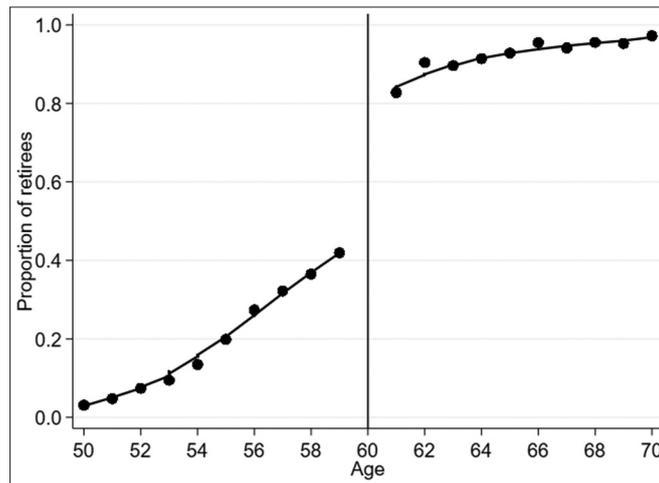


Figure 1. Proportion of retired male household heads by age in urban China: Urban household survey 2002–2009.

Table 2. First-stage estimates of 2SLS and assumption tests of RDD: UHS 2002–2009 (n=20,776).

Variables	First-stage of 2SLS		RDD assumption tests	
	Retired	Ethnic Han	Marital status	Years of education
	β (RSE)	β (RSE)	β (RSE)	β (RSE)
Older than 60 (Ref: No)	0.37(0.01)***			
Retired (Ref: No)		-0.00(0.01)	-0.01(0.01)	-0.20(0.24)
Age-60	0.03(0.00)***	-0.00(0.00)	-0.00(0.00)	-0.07(0.02)***
Retired \times (age-60)		0.00(0.00)***	-0.00(0.00)	0.07(0.02)***
Ethnic Han (Ref: No)	0.01(0.01)		0.01(0.01)	-0.75(0.12)***
Married (Ref: No)	-0.05(0.02)**	0.01(0.01)		0.28(0.21)
Years of education	-0.01(0.00)***	0.00(0.00)***	0.00(0.00)	
Living arrangement (Ref: with spouse only)				
Living alone	0.01(0.03)	0.02(0.01)	-0.74(0.04)***	-0.42(0.31)
Living with children	-0.01(0.00)	-0.00(0.00)	-0.02(0.00)***	-0.51(0.05)***
Constant	0.60(0.03)***	0.95(0.02)***	1.01(0.01)***	12.47(0.30)***
F-value	884.61			

Note: Ref: Reference category, RSE: Robust standard errors. All models control for year fixed effect and county/district fixed effects. RDD: Regression discontinuity design, 2SLS: Two-stage least squares, UHS: Urban household survey. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

rule of thumb value in the literature (Staiger and Stock, 1997). Taken together, these findings suggest the feasibility and validity of using the difference between the male head’s age and the mandatory retirement age as an instrumental variable.

3.3. Testing RDD assumptions

An important assumption of RDD in this study is that other predictors of alcohol expenditure should not be affected by retirement policy and hence should have a smooth distribution around the discontinuity point (i.e., age 60 years). As a formal test, we regressed each of these control variables on retirement status, as well as year fixed effects and county/district fixed effects (i.e., Equation 4). As shown in RDD assumption tests of Table 2, there was no statistically significant association between retirement status and any of the control variables.

3.4. Second-stage estimation

Figure 2 depicts the discontinuity in the distribution of households’ total expenditure on alcohol. The average annual household expenditure on alcohol increased gradually between ages 50 and 59, dropped by about 50 yuan between ages

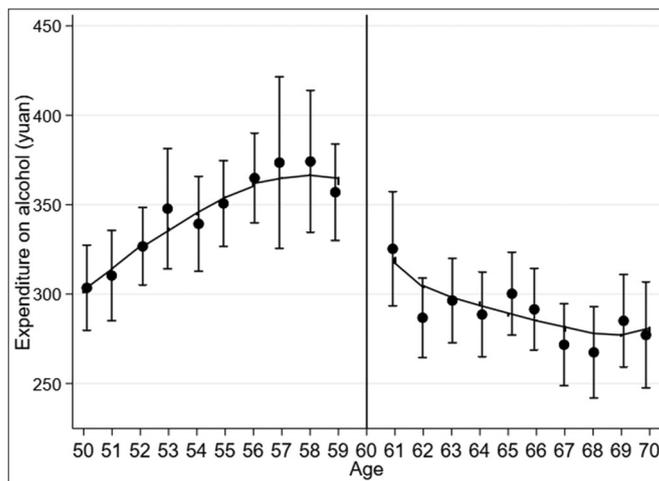


Figure 2. Average total household expenditures on alcohol (with 95% confidence intervals) by male household heads' age: Urban household survey 2002–2009.

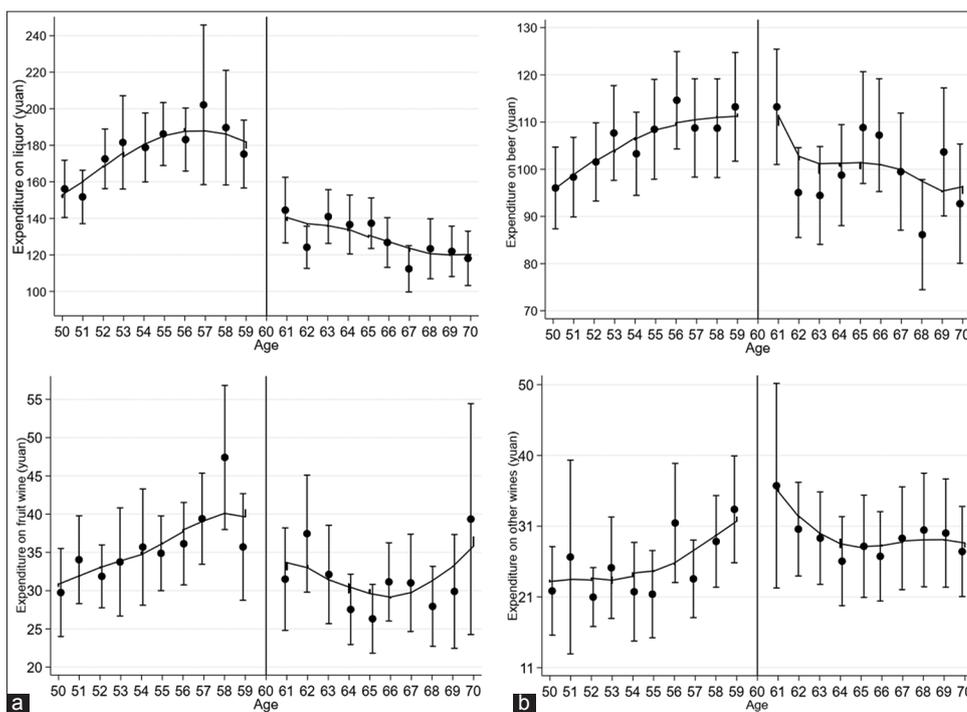


Figure 3. (a and b) Average total household expenditures on alcohol (with 95% confidence intervals) by male household heads' age, stratified by alcohol type: Urban household survey 2002–2009.

59 and 61, and then gradually declined between ages 61 and 70. Figure 3 breaks down the total expenditure by four types of alcohol. Similar patterns as that observed in Figure 3 hold for the expenditure on liquor - which dropped by 40 yuan between ages 59 and 61 - and, to a lesser extent, for the expenditure on fruit wine, which dropped by 7 yuan between ages 59 and 61. The pattern of discontinuity is less pronounced for expenditures on beer or other types of alcohol.

The visual patterns shown in Figures 2 and 3 are confirmed by the second-stage of the 2SLS estimates presented in Table 3. After adjusting for demographic and socioeconomic characteristics, as well as year fixed effects and county/district fixed effects, having a retired male household head reduced the annual total household expenditure on alcohol by 30%. After breaking down by types of alcohol, having a retired male household head reduced the annual household expenditure on liquor by 46%, but did not significantly affect expenditure on any other type of alcohol.

3.5. Testing potential mechanisms

We next investigate two potential mechanisms, which may explain how retirement affects expenditure on alcohol. First, retirement decreases the labor income of the retiree, which makes alcohol consumption less affordable and, in turn, reduces household expenditure on alcohol. This mechanism may be particularly salient for low-income retirees (Brennan, Schutte, and Moos, 2010). Second, sometimes drinking plays an important role in social interaction; however, work-related social interactions may decline substantially after one retires and the demand or opportunity of social drinking may be reduced accordingly, leading to a reduction in household expenditure on alcohol. Several studies found that retired U.S. adults changed their drinking behavior in response to changes in patterns of social interactions and levels of social support (Bacharach, Bamberger, Cohen *et al.*, 2007; Bacharach, Bamberger, Sonnenstuhl *et al.*, 2004).

Table 4 reports regression results testing these two potential mechanisms. To test the first mechanism mentioned above, we regressed annual household disposable income on retirement status of male household heads. The coefficient estimates in Column 1 of Table 4 indicate that having a retired male household head was significantly related to an 18% reduction in the annual household disposable income. In other words, transition into retirement could reduce household expenditure on alcohol by reducing the amount of disposable household income and making alcohol less affordable.

Table 3. Estimated effects of retirement on household alcohol expenditures: UHS 2002–2009 ($n=20,776$).

Variables	Total expenditure on alcohol	Expenditure by alcohol type			
		Liquor	Fruit wine	Beer	Other
	β (RSE)	β (RSE)	β (RSE)	β (RSE)	β (RSE)
Retired (Ref: No)	-0.30(0.10)***	-0.46(0.15)***	-0.19(0.14)	0.09(0.14)	-0.04(0.10)
Age (centered at 60)	0.03(0.01)***	0.03(0.01)**	0.03(0.01)***	0.01(0.01)	0.02(0.01)**
Retired \times age	-0.04(0.01)***	-0.04(0.01)***	-0.03(0.01)***	-0.02(0.01)***	-0.01(0.01)**
Ethnic Han (Ref: No)	-0.02(0.05)	0.13(0.09)	0.04(0.08)	-0.05(0.07)	-0.02(0.04)
Married (Ref: No)	0.10(0.08)	0.30(0.12)**	-0.06(0.12)	0.06(0.12)	-0.02(0.09)
Years of education	-0.01(0.00)***	-0.05(0.00)***	0.03(0.00)***	-0.02(0.00)***	0.00(0.00)
Living arrangement (Ref: With spouse only)					
Living alone	0.19(0.13)	0.40(0.18)**	-0.25(0.19)	-0.08(0.19)	-0.02(0.14)
Living with children	0.13(0.02)***	0.15(0.03)***	0.07(0.03)**	0.17(0.03)***	0.07(0.02)***
Constant	5.06(0.13)***	3.90(0.21)***	1.44(0.19)***	3.09(0.19)***	0.63(0.13)***

Note: Ref: Reference category, RSE: Robust standard errors. The dependent variables are measured on logarithmic scale. All models control for year fixed effect and county/district fixed effects. UHS: Urban household survey. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 4. Estimated effects of retirement on disposable income and household expenditure on eating out: UHS 2002–2009 ($n=20,776$).

Variables	Disposable income	Expenditure on eating out
	β (RSE)	β (RSE)
Retired (Ref: No.)	-0.18(0.03)***	-0.40(0.16)**
Age (centered at 60)	0.02(0.00)***	-0.02(0.01)
Retired \times age	-0.03(0.00)***	-0.01(0.01)
Ethnic Han (Ref: No.)	0.02(0.02)	-0.05(0.09)
Married (Ref: No.)	0.17(0.03)***	0.03(0.14)
Years of education	0.05(0.00)***	0.10(0.01)***
Living arrangement (Ref: with spouse only)		
Living alone	-0.43(0.06)***	0.18(0.19)
Living with children	0.19(0.01)***	0.52(0.03)***
Constant	9.76(0.05)***	5.65(0.22)***

Note: Ref: Reference category, RSE: Robust standard errors. The dependent variables are measured on logarithmic scale. All models control for year fixed effect and county/district fixed effects. UHS: Urban household survey. * $p < 0.05$, ** $p < 0.01$; *** $p < 0.001$

To test the second mechanism mentioned above, we regressed annual household expenditure on eating out. Eating out together plays an important role in establishing and maintaining friend relationships and work-related social networks in Chinese society. The coefficient estimates in Column 2 of Table 4 indicate that having a retired male household head was significantly associated with a 40% reduction in the annual household expenditure on eating out. This suggests that declined social activities and interactions also contribute to the decreased alcohol expenditure after transition into retirement.

3.6. Robustness tests

We performed several additional analyzes to assess the robustness of our findings. First, the analysis presented above focused on monetary costs of alcohol use as the outcome. However, the amount of household expenditure on alcohol captures not only the amount of alcohol consumed but also the unit price of alcohol purchased which can vary by types and brands of alcohol, as well as the location of purchase. Therefore, we tested whether or not our results above may be sensitive to the choice of outcome using amount of alcohol consumed, measured in Chinese *jin* (= 0.5 kg), instead of alcohol expenditure as the outcome. As shown in Appendix Table A1, having a retired male household head was associated with a 20% reduction in the annual amount of total alcohol intake (Column 1) and a 13% reduction in fruit wine intake (Column 2). No significant association was found for other types of alcohol.

We tested whether our RDD estimates might be sensitive to the choice of age bandwidth by specifying five alternative bandwidths centered around the discontinuity point (i.e., age 60), including 51–69, 52–68, 53–67, 54–66, and 55–65 years old. Consistent with the results reported in Table 3, Appendix Table A2 shows that having a retired male household head led to a 32–48% reduction, depending on the choice of age bandwidth, in total household expenditure on alcohol, as well as a 47–69% reduction, again depending on the choice of age bandwidth, and in liquor expenditure. There was no evidence of any significant impact of retirement on expenditures on other types of alcohol.

Finally, we evaluated the robustness of our results by including households whose male heads were 60 years old. The estimates shown in Appendix Table A3 suggest that such a change in sample composition had little impact. Again, consistent with the results reported in Table 3, having a retired male household head led to significant reductions in total household expenditure on alcohol and liquor expenditure.

4. Discussion

This study provides new evidence of the relationship between retirement and alcohol consumption in urban Chinese households, capitalizing on nationally representative, repeated cross-sectional survey data from 2002 to 2009. Adopting a RDD approach to address the challenge of endogeneity, we found strong evidence supporting negative effects of retirement on urban Chinese households' total alcohol expenditure. This finding is in line with the previous Western studies reporting that transition into retirement causes change in expenditure on alcohol (Eibich, 2015). However, these are some difference in contrast to Bacharach, Bamberger, Biron *et al.* (2008), who found that a more forced or involuntary decision is associated with greater drinking. Considering China's special social sophistication and culture, although retirement is a more forced or involuntary decision in China, which are associated with lower levels of alcohol expenditure.

Our outcome variable, measured as the annual household expenditure on alcohol, provides a more comprehensive measurement of drinking than those of some previous studies, which considered various measures of drinking, including a dichotomous indicator of drinking or not (Oshio and Kan, 2017), frequency and intensity of drinking (Müller and Shaikh, 2016; Wang, Steier, and Gallo, 2014). This study contributes to the literature by examining another aspect of drinking-household expenditure on alcohol.

We further distinguished expenditures on different types of alcohol. We found that the retirement-induced reduction in alcohol expenditure was mainly driven by the reduction in liquor expenditure. This finding is not surprising given that liquor is the most popular type of alcohol consumed in China. On the other hand, although drinking has been associated with functional impairments and negative health outcomes, several studies suggest that a low-to-moderate level of drinking is associated with reduced risks of diabetes, frailty, mortality, and so on (Gea, Bes-Rastrollo, Toledo, *et al.*, 2014; Ortolá, Garcíaesquinas, Galán and Rodríguezartalejo, 2016; Ronksley, Brien, Turne *et al.*, 2011). In addition, Rehm, Greenfield, and Rogers, (2001) and Ziebarth and Grabka (2009) documented that moderate alcohol intake has positive effect on health. Fruit wine and other types of alcohol drinks (e.g., herbal wine) contain smaller amount of alcohol, which is less harmful and even healthier compared with liquor. The retired Chinese old adults did not change their expenditures on these types of alcohol. These results are consistent with the previous study.

We also tested two possible mechanisms through which retirement could affect alcohol expenditure - reduction in alcohol expenditure could be attributable to reduced income flow (making alcohol less affordable) and reduced frequency of social drinking after retirement. We found evidence for both of these mechanisms. These findings are consistent with previous research in Western countries showing that alcohol consumption is not only constrained by disposable income but also affected by social interaction (Moos, Schutte, Brennan *et al.*, 2010; Rosenquist, Murabito, Fowler *et al.*, 2010). Similar to other societies,

drinking and eating out together play an important role in social networking in China. It is likely that older Chinese adults become less involved in work-related social activities after retirement and reduce the frequency of social drinking accordingly.

Several limitations should be noted for future research. First, this study is restricted to workers and retirees in China's public sectors where mandatory retirement age is enforced. Therefore, our findings may not be generalized to those who work in private sectors. One challenge of studying the private sectors is the lack of clearly defined, strictly enforced retirement policy, which prohibits a RDD strategy for causal inference. Second, due to the lack of better measures in UHS, we had to rely on household expenditure on eating out as a proxy to test whether reduction alcohol use could be explained by change in social drinking after retirement. Future research should collect better data on social drinking to further test this mechanism. Third, existing research has reached some conclusions that drinking is associated with stressors, life habits (Zantinge, van den Berg, Smit *et al.*, 2014; Zins, Guéguen, Kivimaki *et al.*, 2011); retirement may change work-related stressors or life habits. Due to the lack of appropriate data in UHS, we are unable to test these alternative mechanisms in this study.

Despite these limitations, this study contributes to a better understanding of the relationship between retirement and alcohol in China in important ways. First, the current study is among the first to examine the causal effect of retirement on health behavior in a low- and middle-income country, where the challenges of population aging and health are mounting. Second, we went beyond estimating a reduced-form causal effect by testing two mechanisms that could explain the impact of retirement on alcohol, which has important public policy implications for health behavior intervention in an aging population.

5. Conclusions

This study suggests that the urban Chinese older adults experience substantial change in drinking as they enter retirement. This has important public policy implications as China is facing a severe challenge of rapid population aging. As the Chinese government is contemplating a plan to raise the mandatory retirement age in response to future shortage of labor force supply, the same policy may prolong the duration of heavy alcohol use and induce a negative health impact among middle-aged and older adults who would have retired at an earlier age. Therefore, any change in the retirement policy should take into account not only its economic impact but also its public health consequence.

Authors' Contribution

H Zou and H Xu designed the study, supervised the analysis, drafted and revised the manuscript. H Zou and B Luan prepared the data, performed the analysis, and interpreted the results. K Yu revised the manuscript.

Ethics

No ethics approval was required for this study which analyzes secondary data from China's 2002–2009 UHS. The dataset was obtained from the National Data, a database hosted and maintained by the National Bureau of Statistics of China (<http://data.stats.gov.cn/english/index.htm>) with a signed data use agreement.

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Conflicts of Interest

No conflicts of interest have been reported by the authors.

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Appendix

Appendix Table A1. Estimated effects of retirement on annual household amount of alcohol intake (Chinese jin): UHS 2002–2009 ($n=20,776$).

Variables	Amount of alcohol intake by alcohol type			
	Liquor	Fruit wine	Beer	Other
	β (RSE)	β (RSE)	β (RSE)	β (RSE)
Retired (Ref: no)	-0.2(0.10)**	-0.13(0.06)**	0.05(0.11)	-0.08(0.06)
Age (centered at 60)	0.02(0.01)***	0.02(0.00)***	0.01(0.01)	0.01(0.00)***
Retired \times age	-0.02(0.01)***	-0.01(0.00)***	-0.02(0.01)***	0.00(0.00)
Ethnic Han (Ref: no)	0.01(0.06)	-0.02(0.03)	-0.03(0.06)	-0.01(0.02)
Married (Ref: no)	0.21(0.08)**	0.07(0.05)	0.05(0.10)	-0.01(0.05)
Years of education	-0.05(0.00)***	0.01(0.00)***	-0.02(0.00)***	-0.01(0.00)***
Living arrangement (Ref: with spouse only)				
Living alone	0.18(0.12)	0.02(0.08)	0.00(0.15)	0.06(0.09)
Living with children	0.09(0.02)***	0.01(0.01)	0.16(0.02)***	0.04(0.01)***
Constant	1.65(0.14)***	0.24(0.08)	2.30(0.16)***	0.26(0.08)***

Note: Ref: Reference category, RSE: Robust standard errors. The dependent variables are measured on logarithmic scale. All models control for year fixed effect and county/district fixed effects. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. UHS: Urban household survey

Appendix Table A2. Regression results using different age ranges of male household heads: UHS 2002–2009.

Age range (years)	Total expenditure on alcohol	Expenditure by alcohol type			
		Liquor	Fruit wine	Beer	Other
		β (RSE)	β (RSE)	β (RSE)	β (RSE)
51–69	-0.32(0.11)***	-0.53(0.17)***	-0.15(0.15)	0.12(0.15)	-0.06(0.11)
52–68	-0.25(0.12)**	-0.47(0.19)**	-0.19(0.17)	0.24(0.17)	-0.04(0.13)
53–67	-0.35(0.14)**	-0.53(0.21)**	-0.31(0.19)	0.17(0.19)	-0.04(0.14)
54–66	-0.48(0.16)***	-0.61(0.25)**	-0.28(0.22)	0.1(0.22)	-0.08(0.16)
55–65	-0.48(0.17)***	-0.69(0.27)**	-0.14(0.25)	0.23(0.25)	-0.1(0.18)

Note: Ref: Reference category, RSE: Robust standard errors. The dependent variables are measured on logarithmic scale. All models control for year fixed effect and county/district fixed effects. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. UHS: Urban household survey

Appendix Table A3. Regression results when age 60 years was included in the sample: UHS 2002–2009 ($n=21,811$)

Variables	Total expenditure on alcohol	Expenditure by alcohol type			
		Liquor	Fruit wine	Beer	Other
		β (RSE)	β (RSE)	β (RSE)	β (RSE)
Retired (Ref: No)	-0.30(0.11)***	-0.42(0.18)**	-0.07(0.16)	0.17(0.16)	-0.02(0.12)
Age (centered at 60)	0.03(0.01)***	0.03(0.01)**	0.02(0.01)**	0(0.01)	0.02(0.01)**
Retired \times age	-0.04(0.01)***	-0.04(0.01)***	-0.03(0.01)***	-0.03(0.01)***	-0.01(0.01)**
Ethnic han (Ref: No)	-0.02(0.05)	0.11(0.08)	0.04(0.07)	-0.05(0.07)	-0.02(0.04)
Married (Ref: No)	-0.18(0.08)**	-0.37(0.12)***	-0.02(0.11)	0.14(0.11)	0.05(0.08)
Years of education	-0.01(0.00)***	-0.05(0.01)***	0.03(0.00)***	-0.02(0.00)***	0.00(0.00)
Living arrangement (Ref: With spouse only)					
Living alone	0.24(0.12)**	0.48(0.18)***	-0.21(0.18)	-0.01(0.18)	0.01(0.14)
Living with children	0.13(0.02)***	0.16(0.03)***	0.07(0.03)***	0.17(0.03)***	0.07(0.02)***
Constant	4.99(0.14)***	3.81(0.22)***	1.35(0.20)***	2.96(0.20)***	0.57(0.14)***

Note: Ref: Reference category, RSE: Robust standard errors. The dependent variables are measured on logarithmic scale. All models control for year fixed effect and county/district fixed effects. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. UHS: Urban household survey

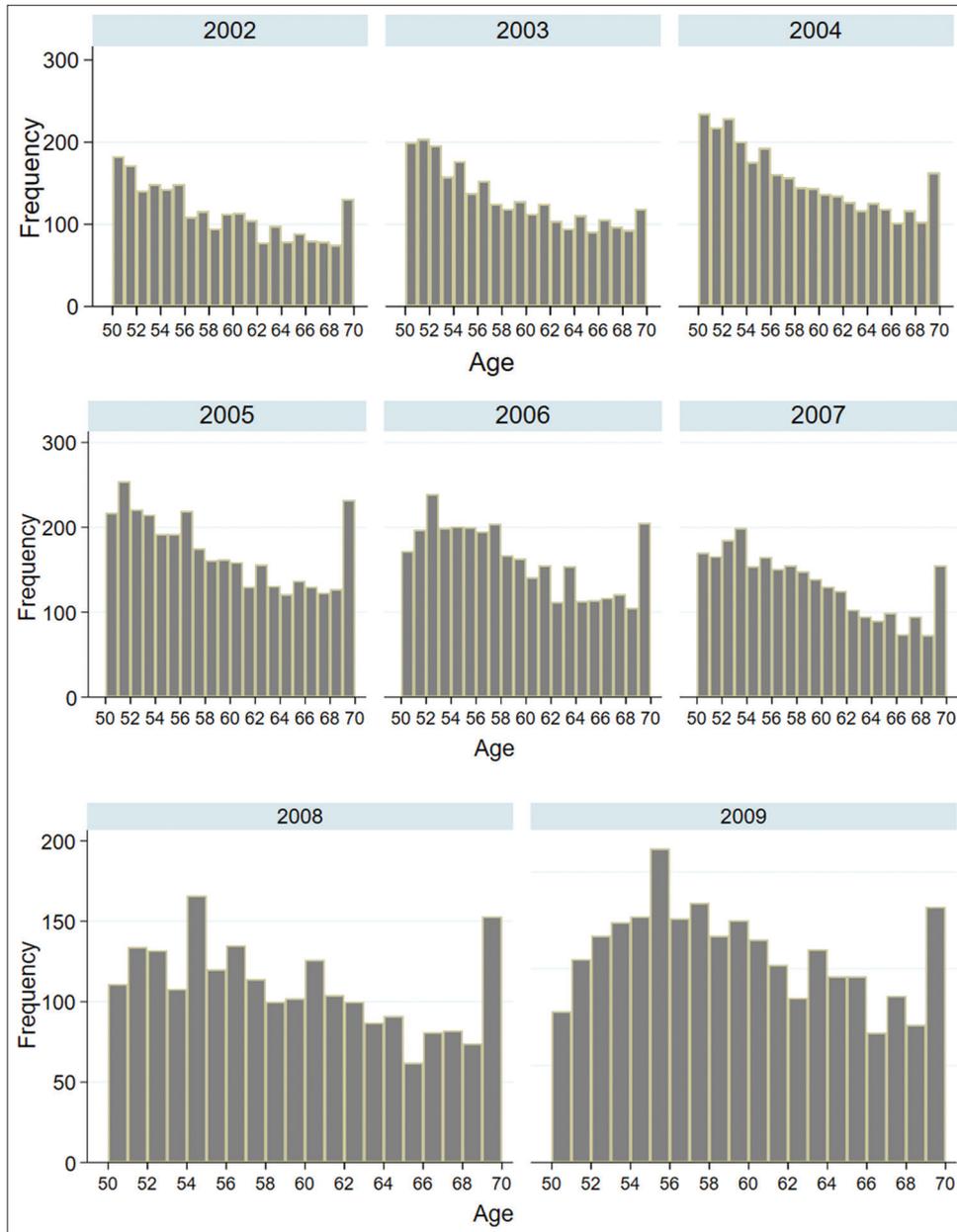


Figure A1. Age distributions of the Urban Household Survey household head in the analytical sample in each year from 2002 to 2009.