Association between alcohol consumption and frailty in three Chinese cities

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Abstract

Background: Frailty is often described as a condition of the elderly but affects all age groups, alcohol consumption is associated with frailty. The aim of this study is to examine the associations between alcohol consumption pattern (ACP) and frailty in three cities in adults. .

Methods: A cross-sectional study was conducted in three cities in China from June 2017 to October 2018. In total, 20,716 residents aged ≥ 18 years old were selected by using a multi-level stage sampling procedure. Alcohol consumption pattern was assessed by CAGE four-item questionnaire. Frailty was measured by a validated Chinese version of the FRAIL scale. Multinomial logistic regressions were used to examine the association of ACP with pre-frailty and frailty after controlling for varied covariates. **Results:** In general, the prevalence of pre-frailty and frailty was 35.25% and 11.42%, respectively. After controlling for covariates and interaction of age and ACP, non-problematic drinkers neither had association with pre-frailty(OR: 1.13, 95%CI:0.97-1.31) nor with frailty(OR:0.86,95%CI:0.68-1.12), while problematic drinkers had high odd ratios of pre-frailty(OR: 1.35, 95%CI:1.06-1.72) and frailty(OR:1.52, 95%CI:1.02-2.26) compared with non-drinker.

Conclusions: our study found a positive association between problematic drinking and (pre-) frailty, no relationship between non-problematic drinking and (pre-) frailty compared with non-drinking among whole Chinese population. Based on previous findings and ours, we conclude it is important for the prevention of frailty to advocate zero drinking among whole population. **Keywords:** alcohol consumption, frailty, life course

Background

Frailty is a medical syndrome with multiple causes and contributors that is characterised by diminished strength, endurance, and reduced physiological function that increases an individual's vulnerability for developing increased dependency and/or death [1]. Although an ageing population is vulnerable to frailty[2], a life course approach is warranted[3]. A life course approach can identify what factors across the life course influence the trajectory of frailty. From a public health perspective, if we can identify vulnerable population and risk factors to frailty early, effective interventions may be able to modify such a trajectory and delay the emergence of frailty[3].

Several studies have found disadvantaged childhood socioeconomic conditions[4, 5], low leisure-time physical activity[6–8], and cigarette smoking[9, 10] are positively associated with incidence of frailty over the life course. Harmful alcohol consumption is one of the leading risk factors for population health worldwide and has a direct impact on many health outcomes, including maternal and child health, infectious diseases, noncommunicable diseases and mental health, injuries and poisonings[11]. However, a meta-analysis indicated that the associations of alcohol consumption with healthy ageing are equivocal[12].

According to the current evidence, the relationship between alcohol consumption and frailty among ageing population is very complex and inconsistent. Two meta-analyses even concluded contradictory conclusions, one[13] found that heavier alcohol consumption is associated with lower incident frailty compared with no alcohol consumption among community-dwelling middle-aged and older. The other one[14] found that moderate alcohol consumption is associated with a lower risk of frailty, while higher consumption levels is associated with a higher risk of frailty. Another meta-analysis[15] indicated that alcohol consumption is not associated with sarcopenia, which is one important component of frailty. A longitudinal study-based life course approach found that high consumption in midlife predicted both frailty and prefrailty, but zero and moderate consumption did not compared with light alcohol consumption, however, zero and high consumption were cross-sectionally associated with frailty[16]. After a literature review, we found that most previous studies focused on midlife- and older populations, without controlling for important confounders such as age, gender, education, socioeconomic status, smoking, physical activity and health status. Kojima et al.[13] recommend that future research should both fully adjust for potential confounding factors and examine various measures of alcohol intake, such as quantity, frequency, type or patterns (including harmful drinking), in relation to frailty.

In 2016, the number of deaths due to alcohol consumption in China was about 710,000, and the prevalence of heavy episodic drinking was 22.7% among the population aged 15+ years old[11]. However, social and health problems related to alcohol use and abuse have been largely neglected in China [17]. We also found no study focusing on the relationship between alcohol consumption pattern and frailty in Chinese cities. The aim of this study was to examine the association of alcohol consumption pattern with prefrailty and frailty for a Chinese population aged 18+ years old in three cities

Methods

Participants and study design

Three cross-sectional studies – Evaluation of healthy city projects were conducted in three cities in China- Shanghai, Zhengzhou, and Baoji from June 2017 to October 2018. Participants were selected by a multi-level stage sampling procedure. In the first stage, 16 districts from Shanghai (eastern China), 28 districts from Zhengzhou (central China), and 5 districts from Baoji (western China) were sampled randomly. The three cities represented the eastern, central and western China in our previous study about drinking and social capital. In the second stage, 5% of the population aged 18 years or older were randomly selected from each district selected in the first stage. In total, 22,290 participants were randomly selected to answer undergo the questionnaires anonymously, but 856 participants rejected participation. 20,716 participants were involved in this study after excluding 481 participants with missing data and 237 participants aged under 18 years old. This study was approved by the Institutional Review Board of Fudan University (Ethic Approval Code: IRB#2018-03-0666).

Measures

Frailty

The Chinese version of the FRAIL scale was used to measure frailty[18], which consists of five dichotomous (yes/no) items (fatigue, resistance, ambulation, illness, and loss of weight) from both the Frailty Index (FI) and Freid's Frailty Phenotype (FP), which is widely used in the Asia-Pacific region (3). The FRAIL scores range from 0 to 5 (i.e., 1 point for each component; 0 = best, 5= worst) and represent frail (3–5), pre-frail (1–2), and robust (0) health status.

Alcohol consumption pattern (ACP)

Alcohol consumption pattern was measure by the following questions. Firstly, the participants responded to “Have you ever consumed any alcohol such as beer, wine, spirits during the past 12 months?”. If their responses were *yes* to the first questions, they continued to respond to four dichotomous (yes=1/no=0) items of the Chinese version of CAGE [19]. A higher score on the scale indicates alcohol dependence or addiction, and a total of 2 or more is considered problematic drinking [20]. Participants whose responses to the first question was *no* were recognised as *nondrinkers*; Participants whose responses to the first question was *yes*, but CAGE scale was 0 or 1 were recognised as a *non- problematic drinker*; Participants whose responses to the first question was *yes* and their CAGE scale was greater than or equal to 2 were recognised as a *problematic drinker*.

Covariates

Based on a literature review[21], several sociodemographic factors were selected as covariates: gender, age (10-year categories), educational level (elementary school or lower, junior high school, senior high school, and college or higher), occupational status (recoded into employed and unemployed, including unemployed and retirement), and marital status (recoded into married and unmarried, including unmarried, divorced, and widowed). Other covariates in this study also included self-rated health (categorised as very good, good, fair, or bad), smoking (yes/no), and physical activity (none, irregular, and regular). The methods used to measure the above covariates were described in detail in other literature [22, 23].

Statistical analyses

As well as descriptive analyses, univariate analyses including χ^2 trend tests and Spearman regressions were used to examine the distributions of frailty and ACP through covariates. Second, we used multinomial logistic regressions to examine the association of ACP with pre-frailty and frailty. We estimated the adjusted ORs and their 95% confidence intervals (CIs) of independent variables for frailty. STATA version 13.0 (StataCorp LP, College Station, TX, USA) was used to carry out all analyses.

Results

Descriptive results

In total, 20,716 residents (49.44% men and 50.56% women) aged 18-89 years old responded with a mean age of 47.05 years (SD=14.71). As shown in **Table I**, 27.54% attended college or higher as their highest level of education, 65.57% were employed, and 86.77% were married. Only 11.41% of the participants rated their health status as “very good”, while 28.67% rated their health status as “bad”. The prevalence of smoking was 20.56%, while 31.68% of participants did not undertake physical activity and 22.50% undertook physical activity regularly.

Univariate analyses

As shown in **Table I**, the prevalence of non-problematic drinking and problematic drinking was 12.73% and 10.56% respectively. Univariate analyses indicated that the prevalence of non-problematic drinking (19.05%) and problematic drinking (16.76%) among men were higher than that among women (6.50%, 4.43%); the prevalence of problematic drinking among old participants age 60-69 years. (8.61%) and 70 years and older. (7.80%) were lower than that among younger participants; employed participants (12.35%) and married participants (10.800%) reported higher prevalence of problematic drinking than their counterparts reported. The prevalence of problematic drinking significantly decreased with increasing education level ($P < 0.001$) and increased with improved self-rated health ($P < 0.001$). Current smokers reported much higher prevalence of non-problematic drinking (30.58%) and problematic drinking (29.47%) than never/former smokers reported (8.28% and 5.49%). Of all the characteristics, current smokers also had the lowest percentage of non-drinkers (39.94%). The prevalence of problematic drinking among participants taking no physical activity (7.19%) was lower than that among participants taking physical activity irregularly (12.24%) and regularly (11.60%).

As shown in **Table II**, the overall prevalence of pre-frailty and frailty was 35.25% and 11.42%, respectively. The prevalence of frailty significantly increased with increasing age ($P < 0.001$), decreased with increasing education level ($P < 0.001$) and with increasing self-rated health ($P < 0.001$). Being female and unemployed were associated with a higher level of frailty (both $P < 0.001$). The prevalence of frailty significantly decreased with level of physical activity ($P < 0.001$). The prevalence of frailty among non-drinkers, non-problematic drinkers and problematic drinkers were 11.13%, 9.70% and 15.59% respectively ($P < 0.001$).

Multivariate analysis

The results of multinomial logistic regression models are presented in **Table III**. As age is both associated with drinking and frailty, we added interaction of age and drinking to the models after examining the associations of age and drinking with pre-frailty and frailty (models 1a and 2a).

For risk factors of pre-frailty in model 1, after controlling for other covariates, participants aged 60-69 years had higher odd ratios of pre-frailty (OR: 1.19, 95%CI: 1.04-1.37) compared with participants under 30 years, non-problematic drinkers had non-significantly higher OR of pre-frailty (OR: 1.10, 95%CI: 0.99-1.22), problematic drinkers had significantly higher OR of pre-frailty (OR: 1.29, 95%CI: 1.15-1.16) compared with non-drinkers. **Model 1a** found that interaction of age and drinking was not significant (OR:

0.99, 95%CI: 0.96-1.03), and coefficients of covariates and drinking with pre-frailty didn't change significantly.

For risk factors of frailty in model 2, after controlling for other covariates, participants aged 60-69 years (OR: 1.49, 95%CI: 1.19-1.86) and aged 70 years or older (OR: 1.74, 95%CI: 1.38-2.19) had higher OR of frailty compared with participants under 30 years. Non-problematic drinkers had non-significantly lower OR of frailty (OR: 0.90, 95%CI: 0.76-1.07), problematic drinkers had significantly higher OR of frailty (OR: 1.67, 95%CI: 1.40-1.99) compared with non-drinkers. **Model 2a** found that interaction of age and drinking was not significant (OR: 1.01, 95%CI: 0.96-1.06), and coefficients of covariates and drinking with frailty did not change significantly.

Discussion

To the best of our knowledge, this was the first study to examine the associations of alcohol consumption pattern with pre-frailty and frailty amongst the Chinese population. Firstly, this study confirmed the previous findings that older age, being female, lower education, poor self-rated health, smoking and low level of physical activity were all significantly positively associated with (pre-)frailty[4, 21]. As the focus of this study, we found that problematic drinkers had a higher risk of (pre-)frailty, while non-problematic drinkers had neither higher nor lower risk of (pre-)frailty compared with non-drinkers, which was not consistent with previous findings[13, 14, 16, 24]. A recent longitudinal study also found that moderate drinking had no protective benefit of frailty[25]. Strandberg et al[16] found an alcohol paradox that high, not zero, consumption in midlife predicts old age frailty, while zero consumption in old age is associated with frailty. However, we found no interaction of age and drinking on (pre-) frailty, therefore, problematic drinking is associated with a higher risk of frailty among young, middle-aged and older populations. These conflicting findings may be due to different measurement of alcohol consumption pattern and adjusted confounders among different studies. Previous studies[13, 14] have measured quantity of alcohol consumption, such as light (1–98 g/week), moderate (99–196 g/week), and high consumption (> 196 g/week)[16], whereas we screened for problematic drinking with the validated CAGE scale. These previous studies did not adjust for the key confounding factors, such as self-rated health condition, smoking, physical activity, which were controlled in our study.

Most previous studies have focused on a midlife- and older population, without controlling for important confounders such as age, gender, education, socioeconomic status, smoking, physical activity and health status. The health benefits of moderate alcohol consumption may be distorted because of selection biases, unadjusted confounders and misclassification[26–28]. New evidence demonstrated that the level of consumption that minimises health loss due to alcohol use is zero[29]. Given alcohol can cause diabetes mellitus, cardiovascular diseases, and digestive diseases[11] and especially heavy drinking can cause functional and cognitive impairment among elders[30], drinking is presumably a risk factor of frailty. Several cohort studies and experimental studies have shown that moderate drinking can decrease the C-Reactive Protein (CRP) levels and that the decrease in CRP could protect people from frailty[31, 32]. However, the association of alcohol intake with CRP was J-shaped in women but positive and linear-

shaped in men, and was directly associated with uric acid in men and women[33]. High levels of CRP and uric acid are positively associated with a high risk of frailty[34]. Because of the complex association and undefined mechanism between alcohol consumption and frailty, well-designed studies are warranted in the future.

Although this is the first study among a large sample consisting of a varied age group, some limitations should be noted. First, this was a cross-sectional study; therefore, it was difficult to obtain accurate causal relationships. Further longitudinal studies, such as cohort studies, are essential. Additionally, the data were obtained via an anonymous self-reported questionnaire, so there may have been information bias. Thirdly, we only evaluated alcohol consumption pattern by the CAGE scale and did not collect quantitative data on drinking consumption, frequency. Finally, we tried our best to control confounders, but not all of which can be controlled in one study.

Conclusions

Despite the above limitations, our study found a positive association between problematic drinking and (pre-)frailty, no relationship between non-problematic drinking and (pre-)frailty compared with non-drinking among the Chinese population. Future more, the relationships of alcohol consumption and risk of (pre-)frailty is the same across a varied age group. Based on previous findings and ours, we conclude it is important for the prevention of frailty to advocate zero drinking among whole population.

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Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Fudan University (Ethic Approval Code: IRB#2018-03-0666). All participants signed the informed consent.

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Availability of data and materials: Not applicable

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Authors' contributions:

All authors' specific areas of contributions were listed below.

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Drafting of the manuscript: Xin Nie, Junling Gao.

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Tables

Table 1 Comparisons of alcohol consumption pattern by demographic characteristic through univariate analysis

Characteristic	Frequency (%)	ACP <i>n</i> (%)			<i>P</i>
		Non-drinker	Non-problematic drinker	problematic drinker	
Overall	20,716(100.00)	15,890(76.70)	2,638(12.73)	2,188(10.56)	
Gender					
Male	10,003(49.44)	6,420(64.18)	1,906(19.05)	1,677(16.76)	<0.001
Female	10,229(50.56)	9,111(89.07)	665(6.50)	453(4.43)	
Age (year)					
≤29	2,911(14.05)	2,233(76.71)	336(11.54)	342(11.75)	<0.001
30–39	4,076(19.68)	3,121(76.57)	537(13.17)	418(10.26)	
40–49	4,023(19.42)	3,001(74.60)	512(12.73)	510(12.68)	
50–59	3,950(19.07)	2,986(75.59)	524(13.27)	440(11.14)	
60–69	3,589(17.32)	2,803(78.10)	477(13.29)	309(8.61)	
≥70	2,167(10.46)	1,746(80.57)	252(11.63)	169(7.80)	
Educational level					
Elementary school or lower	2,558(12.46)	1,942(75.92)	294(11.49)	322(12.59)	<0.001
Junior high school	6,656(32.43)	5,018(75.39)	879(13.21)	759(11.40)	
Senior high school	5,659(27.57)	4,319(76.32)	746(13.18)	594(10.50)	
College or higher	5,653(27.54)	4,461(78.91)	694(12.28)	498(8.81)	
Occupational status					
Employed	13,402(65.57)	9,960(74.32)	1,787(13.33)	1,655(12.35)	<0.001
Unemployed	7,038(34.43)	5,712(81.16)	832(11.82)	494(7.02)	
Marital status					
Married	17,858(86.77)	13,636(76.36)	2,294(12.85)	1,928(10.80)	<0.001
Other	2,723(13.23)	2,151(78.99)	333(12.23)	239(8.78)	
Self-rated health					
Bad	5,895(28.67)	4,527(76.79)	794(13.47)	574(9.74)	<0.001
Fair	6,535(31.78)	5,066(77.52)	838(12.82)	631(9.66)	
Good	5,785(28.13)	4,430(76.58)	729(12.60)	626(10.82)	
Very good	2,347(11.41)	1,742(74.22)	260(11.08)	345(14.70)	
Smoking status					
Current	4,146(20.56)	1,656(39.94)	1,268(30.58)	1,222(29.47)	<0.001
Never/former	16,022(79.44)	13,816(86.23)	1,327(8.28)	879(5.49)	
Physical activity					
Non	6,338(31.68)	5,163(81.46)	719(11.34)	456(7.19)	<0.001
Irregular	9,168(45.82)	6,850(74.72)	1,196(13.05)	1,122(12.24)	
Regular	4,501(22.50)	3,353(74.49)	626(13.91)	522(11.60)	

Table 2 Comparisons of frailty by demographic characteristic through univariate analysis

Characteristic	Frequency (%)	Frailty <i>n</i> (%)			<i>P</i>
		Robust	Pre-frailty	Frailty	
Overall	20,716(100.00)	11,049(53.34)	7,302(35.25)	2,365(11.42)	
Gender					
Male	10,003(49.44)	5,632(56.30)	3,312(33.11)	1,059(10.59)	<0.001
Female	10,229(50.56)	5,127(50.12)	3,854(37.68)	1,248(12.20)	
Age (year)					
≤29	2,911(14.05)	1,783(61.25)	923(31.71)	205(7.04)	<0.001
30–39	4,076(19.68)	2,292(56.23)	1,486(36.46)	298(7.31)	
40–49	4,023(19.42)	2,200(54.69)	1,406(34.95)	417(10.37)	
50–59	3,950(19.07)	2,146(54.33)	1,330(33.67)	474(12.00)	
60–69	3,589(17.32)	1,608(44.80)	1,388(38.67)	593(16.52)	
≥70	2,167(10.46)	1,020(47.07)	769(35.49)	378(17.44)	
Educational level					
Elementary school or lower	2,558(12.46)	1,321(51.64)	783(30.61)	454(17.75)	<0.001
Junior high school	6,656(32.43)	3,701(55.60)	2,152(32.33)	803(12.06)	
Senior high school	5,659(27.57)	3,038(53.68)	2,007(35.47)	614(10.85)	
College or higher	5,653(27.54)	2,907(51.42)	2,291(40.53)	455(8.05)	
Occupational status					
Employed	13,402(65.57)	7,560(56.41)	4,593(34.27)	1,249(9.32)	<0.001
Unemployed	7,038(34.43)	3,342(47.49)	2,606(37.03)	1,090(15.49)	
Marital status					
Married	17,858(86.77)	9,453(52.93)	6,403(35.86)	2,002(11.21)	0.41
Unmarried	2,723(13.23)	1,517(55.71)	857(31.47)	349(12.82)	
Self-rated health					
Bad	5,895(28.67)	1,641(27.84)	2,800(47.50)	1,454(24.66)	<0.001
Fair	6,535(31.78)	3,646(55.79)	2,389(36.56)	500(7.65)	
Good	5,785(28.13)	3,980(68.80)	1,533(26.50)	272(4.70)	
Very good	2,347(11.41)	1,689(71.96)	532(22.67)	126(5.37)	
Smoking status					
Current	4,146(20.56)	2,190(52.82)	1,490(35.94)	466(11.24)	0.57
Never/former	16,022(79.44)	8,564(53.45)	5,664(35.35)	1,794(11.20)	
Physical activity					
Non	6,338(31.68)	3,348(52.82)	2,152(33.95)	838(13.22)	<0.001
Irregular	9,168(45.82)	4,661(50.84)	3,416(37.26)	1,091(11.90)	
Regular	4,501(22.50)	2,699(59.96)	1,471(32.68)	331(7.35)	
Drinking					
None	15,890(76.70)	8,604(54.15)	5,518(34.73)	1,768(11.13)	<0.001
Non- problematic drinking	2,638(12.73)	1,394(52.84)	988(37.45)	256(9.70)	
Problematic drinking	2,188(10.56)	1,051(48.03)	796(36.38)	341(15.59)	

Table 3 multinomial logistic regression models for association between drinking patterns and pre-frailty and frailty (reference=robust)

Characteristic	Pre-frailty OR (95%CI)		Frailty OR (95%CI)	
	Model 1	Model 1a	Model 2	Model 2a
Male (vs. Female)	0.78(0.73-0.84)	0.78(0.73-0.84)	0.83(0.74-0.93)	0.84(0.75-0.94)
Age				
≤29	1	1	1	1
30-39	1.04(0.92-1.18)	1.05(0.93-1.20)	0.98(0.78-1.22)	0.96(0.76-1.21)
40-49	0.99(0.88-1.13)	1.01(0.87-1.18)	1.15(0.93-1.43)	1.11(0.86-1.43)
50-59	0.94(0.83-1.08)	0.97(0.80-1.17)	1.13(0.91-1.41)	1.08(0.80-1.45)
60-69	1.19(1.04-1.37)	1.24(0.99-1.55)	1.49(1.19-1.86)	1.39(0.98-1.97)
≥70	1.10(0.95-1.27)	1.15(0.87-1.50)	1.74(1.38-2.19)	1.60(1.07-2.40)
Educational level				
Elementary school or lower	1	1	1	1
Junior high school	1.09(0.98-1.23)	1.09(0.98-1.23)	0.82(0.70-0.96)	0.82(0.70-0.96)
Senior high school	1.26(1.12-1.41)	1.26(1.12-1.41)	0.81(0.69-0.96)	0.81(0.69-0.96)
College or higher	1.80(1.59-2.03)	1.80(1.59-2.03)	0.91(0.76-1.09)	0.91(0.76-1.08)
Employed (vs. Unemployed)	1.02(0.94-1.11)	1.02(0.94-1.11)	0.96(0.85-1.08)	0.96(0.85-1.08)
Married (vs. Unmarried)	1.19(1.07-1.32)	1.19(1.07-1.32)	0.88(0.75-1.03)	0.88(0.75-1.03)
Self-rated health				
Bad	1	1	1	1
Fair	0.38(0.35-0.42)	0.38(0.35-0.42)	0.16(0.14-0.18)	0.16(0.14-0.18)
Good	0.22(0.20-0.24)	0.22(0.20-0.24)	0.08(0.07-0.10)	0.08(0.07-0.10)
Very good	0.18(0.16-0.20)	0.18(0.16-0.20)	0.10(0.08-0.12)	0.10(0.08-0.12)
Current smoking (vs. Other)	1.15(1.05-1.26)	1.15(1.05-1.26)	1.09(0.94-1.27)	1.09(0.94-1.27)
Physical activity				
Non	1	1	1	1
Irregular	1.19(1.08-1.26)	1.17(1.08-1.26)	0.97(0.87-1.09)	0.97(0.87-1.09)
Regular	0.93(0.85-1.02)	0.93(0.85-1.02)	0.58(0.50-0.70)	0.58(0.50-0.68)
Drinking				
None	1	1	1	1
Non- problematic drinking	1.10(0.99-1.22)	1.13(0.97-1.31)	0.90(0.76-1.07)	0.86(0.69-1.11)
Problematic drinking	1.29(1.15-1.46)	1.35(1.06-1.72)	1.67(1.40-1.99)	1.52(1.02-2.26)
Agerinking	-	0.99(0.96-1.03)	-	1.01(0.96-1.06)