International Journal of Mental Health and Addiction (2023) 21:1914–1930
https://doi.org/10.1007/s11469-021-00697-7

ORIGINAL ARTICLE

The Effects of Cigarette Smoking, Alcohol Consumption, and Use of Both Cigarettes and Alcohol on Chinese Older Adults' Sleep: Results from a Longitudinal Study

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Accepted: 25 October 2021 / Published online: 15 November 2021

Abstract
We examined the effects of cigarette smoking, alcohol consumption, and use of both cigarettes and alcohol on changes in sleep quality and duration among Chinese older adults. Using four waves of the Chinese Longitudinal Healthy Longevity Survey (CLHLS), we employed Cox two-state regression models to examine the changes in sleep quality and duration. The results showed the following: (1) Former users (cigarettes and/or alcohol), current alcohol users, current smokers, or users who used both cigarettes and alcohol all reported lower odds of worsening sleep quality (all $p < 0.01$; except former users, which was $p < 0.05$), compared with those who did not smoke and use alcohol at all. (2) Among older adults who maintained poorer sleep quality (from not good to not good), only users of both cigarettes and alcohol were less likely to experience this outcome ($p < 0.05$). (3) Only former users and current smokers had higher odds of transitioning from recommended sleep duration of 7–8 h daily into the non-recommended range (all $p < 0.05$), compared with older adults who did not use cigarettes and alcohol. Chinese older adults may be more adaptive to the cultural norms and traditions of cigarette and alcohol uses. Further research efforts with experimental data are warranted to examine the impact of cigarettes and alcohol on Chinese older adults' sleep.

Keywords Cigarette smoking · Alcohol consumption · Sleep · China · Older adults

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Among older adults, complaints of sleep-related issues have become more common. The biological rhythms and circadian rhythms among older adults are different from those of middle-aged and younger adults (Schmidt et al., 2012). In the USA, approximately 50% of older adults have issues related to sleeping difficulty, and poor sleep quality might lead to higher rates of mortality and morbidity (Neikrug & Ancoli-Israel, 2010). In China, a country with a rapidly growing older adult population, sleep hygiene is also a primary concern for many older adults. In Shanghai, one of the largest mega cities in South China, nearly 42% of older adults had poor sleep quality (Luo et al., 2013). In another study targeting adolescents and older adults in Hunan province, the authors observed that nearly 27% of the study participants reported insomnia (Tang et al., 2017), a type of sleep disorder in which people have trouble falling asleep. Furthermore, although the guideline from the National Sleep Foundation (NSF) recommends that older adults should sleep 7–8 h daily, fewer than 40% of Chinese older adults actually report such daily sleep duration (Hirshkowitz et al., 2015; Lee et al., 2020). Therefore, tackling Chinese older adults' sleep-related problems might be a key to enhance healthy aging in China.

Helping older adults' sleep hygiene is an important direction for public health promotion, but there are other concerns. Cigarette smoking and alcohol consumption are two key challenges associated with chronic conditions like lung cancer, chronic obstructive pulmonary disease, liver cirrhosis, and other cardiovascular diseases. In fact, China has a long history of using tobacco and alcohol products (Hao et al., 2005; Wee, 2016). Approximately 11.5% of global deaths annually (around 6.4 million) were attributed to smoking, with more than 50% of the deaths occurring in China, India, the USA, and Russia (GBD 2015 Tobacco Collaborators, 2017). In China, tobacco-attributed disease burdens declined between 1990 and 2017, but tobacco-attributed death rates among males increased by 50% (Wen et al., 2020). Also, Chinese rural residents tend to smoke significantly more than do their urban counterparts (Lee et al., 2021).

Using tobacco and alcohol products has been normalized in China for a long time because many people use them to build social relationships and gift others during festivals (Lee et al., 2017; Wang et al., 2014). However, the Chinese central government has established several control measures to combat cigarette smoking and alcohol consumption. For example, in 2015, Beijing introduced a policy banning all types of indoor smoking in public areas; however, the proportion of daily smokers decreased only slightly, from 20.7 to 19.2%, between 2014 and 2016 (Li et al., 2018).

In terms of alcohol control, the story is more complicated, given that the Chinese alcohol industry is a large business, with strong impact on policy implementation (Guo & Huang, 2015). The laissez-faire policy regarding alcohol has detrimental effects on human health. Alcohol consumption is the leading risk factor of death and disability; no safe level of alcohol consumption actually can improve human health (Burton & Sheron, 2018; GBD 2016 Alcohol Collaborators, 2018). In a large study targeting 195 countries and territories, more frequent alcohol consumption was shown to increase the risk of all-cause mortality, especially cancer (GBD 2016 Alcohol Collaborators, 2018). Besides, in China, alcohol consumption contributes to more than 310,000 deaths and nearly 14 million disability-adjusted life years (DALYs) among men annually (Jiang et al., 2015). Other factors, like low socioeconomic status, older age, and social pressure, are key variables related to increasing alcohol consumption in China (Gu & Ming, 2020, 2021a). Chinese experts in substance use and public health have called for further action regarding alcohol regulation (Jiang et al., 2015).

Several studies have identified the associations between alcohol consumption and sleep-related problems (Britton et al., 2020; Stein & Friedmann, 2005) and between smoking

and sleep hygiene (Bellatorre et al., 2017; Costa & Esteves, 2018; Jaehne et al., 2012; Liao et al., 2019; Wetter & Young, 1994). Most study results showed detrimental effects of smoking and alcohol consumption on sleep. For example, Britton and colleagues (Britton et al., 2020) observed that problematic alcohol consumption may contribute to more sleep problems among male older adults. In another study targeting the general population in central China, it has been found that sleep disturbance is more prevalent among cigarette smokers, compared with those who did not smoke (Liao et al., 2019).

Interestingly, using the Chinese Longitudinal Healthy Longevity Survey (CLHLS), two studies observed that older adults who smoked or used alcohol had higher odds of reporting better sleep quality, compared with those who did not use cigarettes or alcohol (Gu et al., 2010; Lee et al., 2018). Nevertheless, we need to point out that further research efforts should be directed toward Chinese older adults because the aforementioned studies relied on a cross-sectional study design (Gu et al., 2010; Lee et al., 2018). Another study conducted by Liao and colleagues (Liao et al., 2019) observed that sleep disturbance was more prevalent in cigarette smokers than nonsmokers, but their study was also limited by its cross-sectional design. Studies regarding the longitudinal effects of cigarette smoking and alcohol consumption on sleep among Chinese older adults remain limited. Further longitudinal research should examine the longer-term effects of smoking behavior and alcohol use. The knowledge gaps from the aforementioned literature regarding these inconsistencies need to be addressed to provide more accurate policy implications in the long term.

Our study aims to examine the longitudinal effects of Chinese older adults' cigarette smoking behavior, alcohol consumption, and use of both cigarettes and alcohol on sleep quality and duration, using the longitudinal CLHLS dataset. The Cox two-state regression model was employed to investigate changes in sleep quality and duration among Chinese older adults further, given that sleep quality and duration might change over time. We hypothesized, with the aforementioned literature discussing the detrimental effects of smoking and alcohol consumption (Bellatorre et al., 2017; Britton et al., 2020; Costa & Esteves, 2018; Jaehne et al., 2012; Liao et al., 2019; Wetter & Young, 1994), that cigarette smoking and alcohol consumption are associated with sleep quality and duration among Chinese older adults. Further policy and research implications also are discussed.

Materials and Methods

Study Sample

We extracted longitudinal data from four waves of the CLHLS dataset (2008–2009, 2011–2012, 2014, and 2018). CLHLS is a currently ongoing and publicly available dataset, which examines the health and longevity of Chinese older adults. The dataset is the first of its kind to focus on older adults in a developing nation. The sampling scheme relies on a multi-stage and random sampling method. Furthermore, the investigators oversampled the oldest-old and recruited more male participants in the selected counties and cities. This sampling strategy may reduce gender disparity between older males and females, given that older males may have shorter life expectancy than older females.

This dataset includes international collaborators from major institutions in the USA and China, including Duke University and Peking University. To study Chinese older adults' health and its associated factors, the CLHLS questionnaire covers a wide range of topics such as social policy (social insurance and retirement plan), family relationships, cigarette

and alcohol consumption behaviors, dietary behavior, mental health, disability, and chronic health, among others. The CLHLS investigators conducted face-to-face interviews for data collection and obtained informed consent from all study participants, including older adults (65 years of age or above) and some middle-aged adults. The randomly selected participants are from 23 major mega cities and provinces in China. Further information regarding the CLHLS dataset can be found in Zeng (2012). In terms of the final study sample, we considered participants who were 65 years of age or above from four selected waves of the CLHLS dataset. We chose all older adults who fully answered all questions of interest in each wave and excluded missing information. The final study sample included $n = 39{,}048$ observations. As this study carried out a secondary data analysis using a publicly available and de-identified dataset, Institutional Review Board (IRB) approval was not required.

Outcome Variables

The outcome variables in this research included two self-reported sleep-related measurements: sleep quality ("how do you rate your recent sleep quality?") and sleep duration ("on average, how many hours do you sleep daily including napping?"). For the original coding of sleep quality, the categories included "very bad," "bad," "neutral," "good," and "very good." To avoid skewed distributions (for example, based on raw data, a vast majority of older adults reported "good" or "very good" sleep quality), we followed a dichotomization used by two previous studies (Gu et al., 2010; Lee et al., 2020). We classified older adults who reported "good" and "very good" sleep quality to "good" and those who reported "neutral", "bad," and "very bad" to "not good." For sleep duration, we used the guideline proposed by NSF that older adults are recommended to sleep 7 to 8 h daily (Hirshkowitz et al., 2015). We categorized older adults who slept within this range to "7–8 h" and those who did not sleep within this range to "not within 7–8 h."

Measurements

The primary predictor in this research was the status of cigarette smoking and alcohol consumption. We selected measurements examining older adults' current smoking status and alcohol consumption information. Furthermore, based on responses from the CLHLS questionnaire, we created a new classification to investigate the older adults who used both cigarettes and alcohol during their study participation. Older adults who smoked and/or used alcohol previously but quit when they participated in the survey were categorized as former users of cigarettes and/or alcohol. Therefore, the primary predictor was categorical with the following classifications: "none" (older adults who did not smoke and use alcohol), "former user," "current alcohol user," "current smoker," and "use of both."

Participants' age (65–80, 81–95, and above 95) and gender (male, female) were selected to describe their biological characteristics. We also selected a few variables to represent older adults' socioeconomic status and living arrangement: years of formal education (none, 1–5, 6–10, and 11 and above), marital status (married, others [including those who were divorced, widowed, and never married]), living arrangement (with household members[s], alone, and in an institution), and types of community (rural, urban).

A few other measurements were selected to describe older adults' health status and well-being: exercise status (no, yes), life satisfaction (not good [including those who were very

bad, bad, and neutral], good), and chronic conditions that required inpatient treatments in the past 2 years (none, yes).

Statistical Analysis

Cox two-state regressions were employed to study changes of sleep quality and duration over time. This analytical framework was applied mainly because sleep quality and duration might change over time and because both poor and good sleep habits might alter sleep outcomes (Foley, 2021). Multi-state modeling is a flexible technique to examine patient differences among the various states (Meira-Machado et al., 2009) such as sleep outcomes in this research. For sleep quality, we focused on two different states: from good sleep quality to not good and from not good to not good. We followed the same procedure for sleep duration: from within 7–8 h daily to not within 7–8 h and from not within 7–8 h to not within 7–8 h. We chose the largest value of the nonparametric correlation coefficient Cramer's V to examine the correlations based on four survey waves because our data were longitudinal. Cramer's V is based on chi-square and is appropriate as a majority of the variables selected in this research were categorical.

Statistical results are reported using two components. The first component was the sample characteristics of the final study sample. The second component was the results of Cox two-state regression models. For the regressions, hazard ratios (HR; reference level of HR = 1.00) and 95% confidence interval (95% CI) were reported as the main statistical results. All statistical tests were two-tailed with a significance threshold of 0.05 ($p < 0.05$). All regression models were controlled for the same set of covariates, using the same primary predictor. The free and publicly available statistical package R (version 3.6.2) was used for all data analyses.

Results

Sample Characteristics

Sample characteristics are shown in Table 1. In the overall final study sample ($n = 39{,}048$), approximately 7.2% of older adults smoked cigarettes and used alcohol at the same time, 9.4% used alcohol only, 10.3% smoked cigarettes only, and 16.6% were former users of cigarettes and/or alcohol. Approximately 60.4% of older adults reported good sleep quality, and 39.6% of study participants reported not good sleep quality. Only 37.4% of older adults slept within the recommended range of daily sleep duration, 7–8 h. A majority of the older adults were below 95 years of age and female. More than 55% of older adults had not received any formal education, were not married (60.5%), lived with at least one household member (80.6%), and resided in rural areas (52.2%). Only 31.8% were physically active. Approximately 63.9% of the older adults reported good life satisfaction. Nearly 80% of the older adults (79.5%) did not suffer from chronic conditions that required inpatient treatments in the past 2 years.

Further sample characteristics, categorized by sleep quality and duration, can be found in Table 1. Results from nonparametric Cramer's V correlations between selected variables are shown in Table 2.

Table 1 Sample characteristics by sleep quality and duration among Chinese older adults: the Chinese Longitudinal Healthy Longevity Survey ($n=39,048$)

		Sleep quality		Sleep duration	
	Overall *N* (%)	Good *N* (%)	Not good *N* (%)	Within 7–8 h *N* (%)	Not within 7–8 h *N* (%)
	39,048 (100)	23,578 (60.38)	15,470 (39.62)	14,609 (37.41)	24,439 (62.59)
Smoking and alcohol consumption status					
None	22,070 (56.52)	12,483 (52.94)	9587 (61.97)	8144 (55.75)	13,926 (56.98)
Former user	6484 (16.61)	3983 (16.89)	2501 (16.17)	2333 (15.97)	4151 (16.99)
Current alcohol user	3673 (9.41)	2533 (10.74)	1140 (7.37)	1457 (9.97)	2216 (9.07)
Current smoker	4010 (10.27)	2628 (11.15)	1382 (8.93)	1525 (10.44)	2485 (10.17)
Use of both	2811 (7.20)	1951 (8.27)	860 (5.56)	1150 (7.87)	1661 (6.80)
Age (in years)					
65–80	14,460 (37.03)	8727 (37.01)	5733 (37.06)	6475 (44.32)	7985 (32.67)
81–95	16,726 (42.83)	9940 (42.16)	6786 (43.87)	5759 (39.42)	10,967 (44.87)
Above 95	7862 (20.13)	4911 (20.83)	2951 (19.08)	2375 (16.26)	5487 (22.45)
Gender					
Male	17,726 (45.4)	11,545 (48.97)	6181 (39.95)	7007 (47.96)	10,719 (43.86)
Female	21,322 (54.6)	12,033 (51.03)	9289 (60.05)	7602 (52.04)	13,720 (56.14)
Education (in years)					
None	21,500 (55.06)	12,580 (53.35)	8920 (57.66)	7393 (50.61)	14,107 (57.72)
1 ~ 5	9246 (23.68)	5693 (24.15)	3553 (22.97)	3603 (24.66)	5643 (23.09)
6 ~ 10	6385 (16.35)	4119 (17.47)	2266 (14.65)	2756 (18.87)	3629 (14.85)
11 and above	1917 (4.91)	1186 (5.03)	731 (4.73)	857 (5.87)	1060 (4.34)
Marital status					
Married	15,425 (39.5)	9539 (40.46)	5886 (38.05)	6584 (45.07)	8841 (36.18)
Others	23,623 (60.5)	14,039 (59.54)	9584 (61.95)	8025 (54.93)	15,598 (63.82)
Living arrangement					
With household member(s)	31,484 (80.63)	19,318 (81.93)	12,166 (78.64)	11,945 (81.76)	19,539 (79.95)

Table 1 (continued)

		Sleep quality		Sleep duration	
	Overall *N* (%)	Good *N* (%)	Not good *N* (%)	Within 7–8 h *N* (%)	Not within 7–8 h *N* (%)
	39,048 (100)	23,578 (60.38)	15,470 (39.62)	14,609 (37.41)	24,439 (62.59)
Alone	6641 (17.01)	3759 (15.94)	2882 (18.63)	2358 (16.14)	4283 (17.53)
In an institution	923 (2.36)	501 (2.12)	422 (2.73)	306 (2.09)	617 (2.52)
Types of community					
Rural	20,377 (52.18)	12,337 (52.32)	8040 (51.97)	7553 (51.7)	12,824 (52.47)
Urban	18,671 (47.82)	11,241 (47.68)	7430 (48.03)	7056 (48.3)	11,615 (47.53)
Exercise status					
No	26,618 (68.17)	15,502 (65.75)	11,116 (71.86)	9547 (65.35)	17,071 (69.85)
Yes	12,430 (31.83)	8076 (34.25)	4354 (28.14)	5062 (34.65)	7368 (30.15)
Life satisfaction					
Not good	14,095 (36.1)	6745 (28.61)	7350 (47.51)	5046 (34.54)	9049 (37.03)
Good	24,953 (63.9)	16,833 (71.39)	8120 (52.49)	9563 (65.46)	15,390 (62.97)
Chronic conditions that required inpatient treatments in the past 2 years					
None	31,027 (79.46)	19,307 (81.89)	11,720 (75.76)	11,873 (81.27)	19,154 (78.37)
Yes	8021 (20.54)	4271 (18.11)	3750 (24.24)	2736 (18.73)	5285 (21.63)
Wave					
2008–2009	14,360 (36.78)	9368 (39.73)	4992 (32.27)	5440 (37.24)	8920 (36.5)
2011–2012	8299 (21.25)	5121 (21.72)	3178 (20.54)	3020 (20.67)	5279 (21.6)
2014	5745 (14.71)	3519 (14.92)	2226 (14.39)	2246 (15.37)	3499 (14.32)
2018	10,644 (27.26)	5570 (23.62)	5074 (32.8)	3903 (26.72)	6741 (27.58)

Table 2 Descriptive correlations between variables: nonparamatric Cramer's V

	Sleep quality	Sleep duration	Smoking and alcohol consumption status	Age	Gender	Education	Marital status	Living arrangement	Types of community	Exercise status	Life satisfaction	Chronic conditions[1]
Sleep quality												
Sleep duration	0.20**											
Smoking and alcohol consumption status	0.12**	0.06**										
Age	0.03*	0.14**	0.14**									
Gender	0.11**	0.07**	0.54**	0.21**								
Education	0.07**	0.11**	0.16**	0.27**	0.46**							
Marital status	0.06**	0.12**	0.20**	0.53**	0.35**	0.35**						
Living arrangement	0.08**	0.04*	0.06**	0.10**	0.09**	0.08**	0.36**					
Types of community	0.03**	0.02	0.09**	0.04*	0.03**	0.22**	0.02	0.12**				
Exercise status	0.08**	0.07**	0.12**	0.22**	0.14**	0.26**	0.14**	0.03**	0.21**			
Life satisfaction	0.23**	0.05**	0.04**	0.07**	0.02	0.05**	0.03**	0.10**	0.06**	0.10**		
Chronic conditions[1]	0.08**	0.06**	0.16**	0.07**	0.04**	0.07**	0.06**	0.06**	0.10**	0.07**	0.05**	

Chi-square test: *$p < 0.05$; **$p < 0.01$

[1]Chronic conditions: chronic conditions that required inpatient treatments in the past 2 years

Effects of Smoking and Alcohol Consumption Status on Sleep Quality and Duration Among Chinese Older Adults

Table 3 shows the effects of smoking and alcohol consumption status on sleep quality and duration among Chinese older adults, estimated by Cox two-state regression models. In the first model regarding sleep quality, smoking and alcohol consumption status was negatively associated with worsening sleep quality (from good to not good). Former users (HR = 0.95, 95% CI: 0.90, 1.00), current alcohol users (HR = 0.74, 95% CI: 0.69, 0.79), current smokers (HR = 0.84, 95% CI: 0.78, 0.90), and those who used both cigarettes and alcohol (HR = 0.76, 95% CI: 0.70, 0.83) all reported lower likelihood of worsening sleep quality (all $p < 0.01$, except former users, for whom $p < 0.05$), compared with those who did not smoke and use alcohol at all. Only older adults who used both cigarettes and alcohol were significantly less likely to maintain poorer sleep quality (from not good to not good) (HR = 0.78, 95% CI: 0.65, 0.94; $p < 0.05$). In terms of sleep duration, only former users (HR = 1.05, 95% CI: 1.01, 1.10; $p < 0.05$) and current smokers had higher likelihood of falling out from the recommended sleep duration of 7–8 h daily to the non-recommended range (HR = 1.05, 95% CI: 1.00, 1.10; $p < 0.05$), compared with older adults who did not use cigarettes and alcohol. All other smoking and alcohol consumption categories were not associated with the sleep duration measurement (Table 3).

Discussion

We conducted a secondary analysis by using the CLHLS longitudinal data to examine the effects of cigarette smoking, alcohol consumption, and use of both cigarettes and alcohol on outcomes of sleep quality and duration among Chinese older adults. Cox two-state regressions enabled us to capture changes in sleep quality and duration over time. However, the results were somewhat surprising, given that former and current users had lower odds of reporting worsening sleep quality, compared with those who were abstainers. Furthermore, older adults who used both cigarettes and alcohol were less likely to maintain poorer sleep quality over time, compared with those who were abstainers. In this research, the findings consistent with previous literature investigating the detrimental effect of smoking on sleep (Liao et al., 2019) were about the relationships (1) between current cigarette smoking and the condition of falling out of the recommended sleep duration and (2) between former use and the condition of falling out of the recommended sleep duration for older adults of 7–8 h daily. Our observations may be explained in a few ways.

We should point out that a majority of the Chinese older adults included in this research did not have any chronic conditions that required inpatient treatments in the past 2 years. In other words, the participants were mostly healthy in the study sample. When people enter later adulthood, changes in health behavior or lifestyle may affect their health and well-being. For example, previous studies (Hsieh et al., 2007; Lee et al., 2002) showed that when older adults change their living arrangement, such as moving into an institution, they are required to make lifestyle adjustments and form new social networks that they need to adapt to the new environment. However, a majority of these older adults could have more than one type of chronic health condition, and major lifestyle changes might worsen these older adults' health and well-being conditions in general (Hsieh et al., 2007).

Table 3 Associations of cigarette smoking, alcohol consumption, and use of both with sleep quality and sleep duration among Chinese older adults: the Chinese Longitudinal Healthy Longevity Survey

	Sleep quality		Sleep duration	
	Good to not good	Not good to not good	Within 7–8 h to not within 7–8 h	Not within 7–8 h to not within 7–8 h
	HR 95% CI	HR 95% CI	HR 95% CI	HR 95% CI
Smoking and alcohol consumption status				
None				
Former user	0.95 (0.90, 1.00)*	0.93 (0.83, 1.04)	1.05 (1.01, 1.10)*	1.05 (0.98, 1.13)
Current alcohol user	0.74 (0.69, 0.79)**	0.93 (0.80, 1.08)	1.00 (0.95, 1.05)	0.97 (0.88, 1.06)
Current smoker	0.84 (0.78, 0.90)**	0.89 (0.77, 1.04)	1.07 (1.02, 1.13)**	1.01 (0.92, 1.10)
Use of both	0.76 (0.70, 0.83)**	0.78 (0.65, 0.94)**	1.02 (0.96, 1.08)	1.03 (0.93, 1.15)
Age (in years)				
65–80				
81–95	1 (0.96, 1.05)	1.04 (0.96, 1.14)	1.24 (1.2, 1.29)**	1.19 (1.12, 1.27)**
Above 95	0.88 (0.83, 0.93)**	0.88 (0.77, 1.00)	1.36 (1.3, 1.42)**	1.26 (1.16, 1.37)**
Gender				
Male				
Female	1.19 (1.13, 1.24)**	1.21 (1.09, 1.34)**	1.02 (0.99, 1.06)	1.03 (0.97, 1.10)
Education (in years)				
None				
1 ~ 5	1.01 (0.96, 1.06)	0.97 (0.88, 1.07)	0.97 (0.94, 1.01)	0.94 (0.88, 1.01)
6 ~ 10	0.91 (0.86, 0.96)**	0.97 (0.85, 1.10)	0.92 (0.88, 0.97)**	0.9 (0.82, 0.98)*
11 and above	0.97 (0.89, 1.06)	1.06 (0.84, 1.32)	0.86 (0.8,0.93)**	1 (0.87, 1.15)
Marital status				
Married				
Others	1.02 (0.97, 1.07)	1 (0.91, 1.10)	1.07 (1.03, 1.11)**	1.09 (1.02, 1.16)**
Living arrangement				

Table 3 (continued)

	Sleep quality		Sleep duration	
	Good to not good	Not good to not good	Within 7–8 h to not within 7–8 h	Not within 7–8 h to not within 7–8 h
	HR 95% CI	HR 95% CI	HR 95% CI	HR 95% CI
With household member(s)				
Alone	1.03 (0.98, 1.08)	1.11 (1.01, 1.22)*	1.01 (0.97, 1.05)	1.05 (0.98, 1.12)
In an institution	1.13 (1.02, 1.26)*	1.1 (0.85, 1.43)	1.05 (0.97, 1.15)	1.09 (0.92, 1.29)
Types of community				
Rural				
Urban	0.99 (0.95, 1.03)	1.04 (0.96, 1.12)	0.97 (0.94, 1.00)*	1.02 (0.97, 1.07)
Exercise status				
No				
Yes	0.82 (0.79, 0.86)**	0.99 (0.91, 1.07)	0.92 (0.89, 0.95)**	1 (0.95, 1.06)
Life satisfaction				
Not good				
Good	0.52 (0.5, 0.54)**	0.67 (0.62, 0.72)**	0.94 (0.91, 0.96)**	0.95 (0.9, 1.01)
Chronic conditions that required inpatient treatments in the past 2 years				
No				
Yes	1.22 (1.17, 1.28)**	1.23 (1.14, 1.33)**	1.1 (1.07, 1.14)**	1.09 (1.03, 1.16)**

*$p < 0.05$; **$p < 0.01$

Two major details in this research should be emphasized. First, as previously mentioned, older adults included in our study sample were mostly healthy without any chronic conditions. Only 20.5% had at least one type of chronic condition that required inpatient treatment in the past 2 years. Second, more than 80% of older adults lived with household members. Under these two conditions, we speculate that these older adults may not adjust their health behaviors such as smoking and alcohol consumption. Consequently, these older adults may not develop worsened sleep quality, which in turn is highly associated with their health and psychological well-being measured as chronic conditions and life satisfaction. We also observed that older adults with good life satisfaction had lower odds of worsening sleep quality, compared with their counterparts who felt not good about their life.

It is important to emphasize that we are not advocating cigarette smoking and alcohol consumption among older adults. It is certain that changing unhealthy behaviors can have a good effect on older adults' health (Burbank et al., 2000), but changing health behaviors is easier said than done. The complexity of adjusting older adults' habitual behaviors may change older adults' well-being at the same time, especially those without sufficient support from family members or public health practitioners. It is imperative to assess older adults' mental health when they are asked to change their habitual behaviors. Further clinical studies may be needed to study the long-term effects of unhealthy behaviors and related health outcomes, such as sleep, keeping in mind that studies with longitudinal data such as CLHLS by definition collect data from "survivors."

One might speculate that the sick quitter effect might occur because non-current users might have higher health risks (Park et al., 2017). However, it is noteworthy to mention the observation from the modeling of sleep duration that former users and current smokers had 5% and 7% greater chances respectively of falling out of the recommended daily sleep duration, compared with those who did not use cigarettes and alcohol. These results are not consistent with the sicker quitter effect. If this effect exists in the present research, the results should show a negative association with the recommended daily sleep duration, not a positive association. These inconsistencies regarding the association between older adults' sleep hygiene and their smoking and alcohol consumption warrant further research to derive a more conclusive claim, especially regarding nuances between sleep quality and sleep duration.

Previous studies (Gu et al., 2010; Lee et al., 2018) using a cross-sectional design found positive associations between smoking and sleep quality and between alcohol consumption and sleep quality. Although cross-sectional studies such as Gu et al. (2010) and Lee et al. (2018) may not assess incidence, their observations may not occur by chance. These inconsistencies also can be interpreted through cultural context. In the USA, 66% of lifetime smokers with mental health problems smoked in the past month, compared with just 47.4% of lifetime smokers without mental health illnesses (National Institute on Drug Abuse, 2021). In other parts of the Western world, such as Sweden, people with mild to moderate depression also manifest greater alcohol consumption (Ahlin et al., 2015).

In Western culture, alcohol consumption has been considered a way to cope with stress, but alcohol consumption is not a preferred method to cope with stress in China as has been shown for male alcohol users (Gu & Ming, 2021b). This discrepancy might be explained by featuring the unique characteristics of alcohol consumption in China. Sudhinaraset and colleagues (Sudhinaraset et al., 2016) noted the heavy exposure of Western societies, particularly in the USA, to advertising and marketing emphasizing the virtues of alcohol consumption to both adults and adolescents, more recently through social media. Ethnicity and race play a role as well, with Whites in the USA more likely to engage in alcohol consumption than other ethnic and racial groups. Western society more generally (Vallee, 1998) has

long prioritized consumption of alcoholic beverages (characterized in Latin as *aqua vitae*, or "water of life") over frequently unpotable water supplies and has a long tradition of church-dominated alcohol production and distribution as well as anti-alcohol temperance movements.

In the Chinese cultural context, cigarettes and alcohol products are common gifts (Lee et al., 2017; Wang et al., 2014; Xu et al., 2016), in which case people may use these products to represent a type of social bonding, especially among friends or family members. This is very common for important festivals in Chinese culture, such as the Lunar New Year and the Mid-Autumn Festival. When people perceive or maintain stronger social bonds, it is more likely to improve health in general (National Institutes of Health, 2018). The smoking and alcohol consumption behaviors may have been "normalized" among Chinese older adults in their perspectives and traditions. This perception of tobacco product is also popular in other parts of the world, such as the Eastern Mediterranean region. For example, waterpipe tobacco smoking is popular in the Eastern Mediterranean region, where people use these products to explore their socio-cultural dynamics and where its socio-cultural acceptability has increased (Afifi et al., 2013). In addition, in Southern Iran, hookah consumption is one of the choices for amusement during leisure time (Dadipoor et al., 2019).

There are other potential interpretations of our findings. As physiological responses of older adults are likely to be slower, compared with those of younger survey respondents (Ukraintseva et al., 2021), it is possible that substance-using older adults had lower self-reported rates of using each substance. Another perspective to consider is Maslow's hierarchy of needs (Maslow, 1943). When older adults use cigarettes and alcohol to fulfill their needs as necessities, they are more likely to report better sleep quality as cigarettes and alcohol might have become an important part of their life. This circumstance among older adults could be associated with our previous discussion regarding the Chinese custom that cigarettes and alcohol are used to represent social relationships. With stronger social bonding, health-related measurements might be better, including sleep hygiene. However, further experimental research efforts and cessation programs need to ascertain whether such social bonding with cigarettes and alcohol actually can affect sleep or health-related outcomes. We cannot make a conclusive claim regarding this potential causal inference with the available observational data.

Policy and Research Implications

As previously mentioned, we are not advocating cigarette smoking and alcohol consumption by any means, especially given the detrimental effects of both behaviors on human health based on previous studies (GBD 2015 Tobacco Collaborators, 2017; GBD 2016 Alcohol Collaborators, 2018; Jiang et al., 2015; Wen et al., 2020). When public health practitioners and policy-makers implement interventions for smoking and/or alcohol use cessation targeting Chinese older adults, they need to be aware of the cultural norms and the history of the Chinese tradition of using cigarettes and alcohol. Older adults may be more adaptive to these cultural norms in terms of smoking and alcohol consumption behaviors than individuals from younger generations. Other beneficial health behaviors associated with better sleep should be considered, not cigarette smoking and alcohol consumption. For example, older adults should engage in more frequent physical activity,

which is effective to maintain good sleep hygiene, as demonstrated in this research as a covariate.

The Chinese central government and its public health agency should discourage people from using tobacco and alcohol products as gifting options or as a way to strengthen social bonding. In addition, public health and medical researchers, if possible, should conduct experimental studies to observe the impacts of smoking and alcohol consumption behaviors among Chinese older adults to establish a more conclusive claim.

Study Limitations

We should state a few study limitations as caveats to indicate that further research efforts might be needed to resolve these limitations. First, all sleep-related measurements were self-reported in this research. The CLHLS survey asked only very basic questions related to older adults' sleep hygiene. In addition, the CLHLS investigators did not use established sleep indexes, such as the Pittsburgh Sleep Quality Index (PSQI), to collect participants' sleep information. Other concerns like social desirability may create study bias because the responses may be more socially acceptable than the "true" answers (Phillips & Clancy, 1972; Vesely & Klöckner, 2020). For example, participants with poor sleep quality may not provide a true answer to their response, in which case smokers or alcohol users may not want to disclose their real health status. However, Wu and colleagues (Wu et al., 2013) discussed that self-reported health measurements can provide sufficient information to study participants' objective health condition. A meta-analysis by Vesely and Klöckner (2020) concluded that the effects of social desirability are minimal, but further research efforts should continue to examine the potential effects of social desirability and reduce these concerns. Therefore, self-report bias and social desirability may not be primary concerns in assessing sleep quality and duration in this research. Nevertheless, it would still be more informative if the questionnaire had included more sleep-related measurements like severity of sleep problems or sleep disturbances.

Second, we did not include the amount of cigarettes smoked or alcohol used, mainly because responses regarding the amount of consumption had too many inconsistencies or missing values from the 2008 survey to the 2018 survey. Excessive data imputation might lead to inaccurate estimates of the study results.

Third, the sampling weight captures only age, sex, and types of community among the study participants and does not include other compositional variables like socioeconomic and marital statuses (Gu et al., 2010). Therefore, we did not apply sample weights to our regression models, given that weighted regression results are more likely to increase standard errors for the estimates (Gu et al., 2010) especially when the weighting scheme is not able to capture other important compositional variables.

Last but not least, secondary observation data were used for this research. We were able to investigate the effects of smoking behavior and alcohol consumption on sleep only retrospectively. Further research based on randomized controlled trials may be needed to examine this topic of interest.

Conclusion

In spite of these limitations, our study adds to the body of literature showing the effects of cigarette smoking and alcohol consumption on sleep-related outcomes among Chinese older adults. Some observations in this research seem paradoxical, but within the Chinese cultural context, they may represent cultural differences regarding smoking behavior and alcohol consumption between Western and Eastern worlds, especially among older adults. When public health practitioners implement health interventions to promote health among Chinese older adults, such as smoking and alcohol use cessation programs, they need to be aware of the Chinese traditions and the long history of cigarette smoking and alcohol consumption in China. The complexity of adjusting Chinese older adults' lifestyle should be examined further, and other study results from Western populations should be applied carefully to the Chinese older adult population.

Acknowledgements We sincerely thank two anonymous reviewers and the handling editor who provided valuable comments to improve the quality of this research. Data used for this research were provided by the "Chinese Longitudinal Healthy Longevity Survey" (CLHLS) managed by the Center for Healthy Aging and Development Studies, Peking University. CLHLS is supported by funds from the US National Institutes on Aging (NIA), China Natural Science Foundation, China Social Science Foundation, and United Nations Population Fund. We thank research participants and researchers for their efforts in collecting the CLHLS data.

Declarations

Ethics Approval The research ethics committees of Duke University and Peking University approved the CLHLS study and design (IRB00001052-13074). All participants provided informed consent to the data investigators. Because this study relied on secondary data analysis, further documentations from Institutional Review Board (IRB) were not required at authors' institutions. No experimental interventions were conducted.

Competing Interests The authors declare no competing interests.

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