Research

The joint effects of leisure activity and alcohol drinking on mild cognitive impairment (MCI) in Korean adults: Analysis of the 2019 Korea Community Health Survey

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Abstract

Objectives: Several studies have reported the individual effects of leisure activity and alcohol drinking on cognitive function, despite the existence of association of leisure activity and alcohol drinking. Therefore, this study investigated the individual and joint effects of leisure activity and alcohol drinking on mild cognitive impairment (MCI).

Methods: This study is a cross-sectional analysis of Korean adults from the nationwide 2019 Korea Community Health Survey. Among the 229,099 participants, 177,065 participants aged over 40 years were selected for this study. We used logistic regression models to examine the association of leisure activity and alcohol drinking frequency with OR for mild cognitive impairment (MCI). To investigate the interaction between leisure activity and alcohol drinking on mild cognitive impairment (MCI), we calculated the additive and the multiplicative scale joint effects of their co-exposure.

Results: In the fully adjusted model, the odds ratio for mild cognitive impairment (MCI) decreased by 0.88 (95% CI: 0.84, 0.91) times with engaging leisure activity, and increased by 1.09 (95% CI: 1.04, 1.15) times with ≥6 times/month alcohol drinking compared to never alcohol drinking. The positive joint effect of leisure activity and alcohol drinking on mild cognitive impairment (MCI) was found on multiplicative scale (p=0.028).

Conclusion: We found that leisure activity improved cognitive function, and alcohol drinking reduced it. In addition, leisure activity and alcohol drinking had a positive joint effect on mild cognitive impairment (MCI) in the Korean population.

keywords: *Leisure Activities, Alcohol Drinking, Cognitive Dysfunction, Health Surveys*

Introduction

Cognitive decline is growing public health concerns for aging population worldwide [1]. Mild cognitive impairment (hereafter, MCI) is a syndrome defined as cognitive decline greater than that expected for an individual's age and education level but that does not interfere notably with activities of daily life [1, 2]. MCI represents early-stage dementia which is a leading cause of disability, institutionalization, and mortality; therefore, it could have a tremendous impact on both individual and society [2, 3].

As limited effective treatment alternatives for MCI and dementia are currently available, identification of risk or protective factors, especially modifying factors, could provide chance for preventing the disorder. Among the proposed protective factors, leisure activities are the most widely studied [4-6]. A cohort study conducted in Finland suggested that leisure-time physical activity at midlife is associated with a decreased risk of dementia [7]. Engaging in leisure activities is compatible with alcohol consumption and heavy drinkers have higher participation rates of outdoor activities [8, 9]. Alcohol drinking has been proposed as a possible risk factor for cognitive impairment [10].

Previous studies have focused on the effect of

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only physical activities among leisure activities on cognitive function, although there exists evidence showing that other types of leisure activities, such as mental and social activities, also have beneficial effects on a variety of health outcomes [5]. In addition, previous studies have only shown evidence of the individual effects of leisure activity and alcohol drinking on MCI [3, 10]; however, no study has investigated the joint effects of leisure activity and alcohol consumption on MCI. Because engaging in leisure activities is associated with alcohol drinking, their co-exposure could have a greater or mitigated effect than individual effect. Therefore, the joint effects of these factors on cognitive function need to be addressed.

Using data from the nationwide representative 2019 Korea Community Health Survey (KCHS), this study investigates the individual and joint effects of leisure activity and alcohol drinking on MCI.

Methods

Data collection and participants

The Korea Community Health Survey (KCHS) was introduced in 2008 to establish regional healthcare plans and obtain health statistics from shi/gun/gu to assess the performance of regional healthcare projects in accordance with the Community Health Act. The data is collected from adults aged 19 years or older via interviews. The sample was extracted from an average of 900 adults per community based on the type of housing within each dong/eup/myeon. Using resident registration address data as a sampling frame, primary sampling locations are selected by probability-proportional-to-size and secondary sampling households are selected by systematic sampling.

This study examined data from 229,099 people in the 2019 KCHS database (Figure 1). We excluded participants less than 40 years old because only participants aged ≥40 years answered the questions for MCI. Those who did not have measurement of cognitive impairment, leisure activity, alcohol drinking frequency and covariates were excluded (n=52,034). In total, 177,065 participants were selected for the study.

Variables

I. Leisure activity, alcohol drinking, and MCI

Leisure activity was coded as "yes" or "no" based on the question, "Do you participate in leisure activity periodically (once per month)?". Alcohol drinking frequency was divided into six categories: never, <1 time/month, 1 time/month, 2-4 times/month, 2-3 times/week and ≥4 times/week. These frequency categories were thought to have little difference of impact on cognitive function; therefore, we re-categorized the frequency of alcohol drinking into the following four groups: *never (reference), ≤1 time/month, 2-5 times/month, and ≥6 times/month.* MCI was coded as *"yes"* or *"no"* based on the question, "Have you experienced cognitive decline in the past 1 year?" for only aged 40 years or older.

II. Covariates

We used demographic and cognitive function-related variables as potential confounders. The covariates we considered were sex, age, education

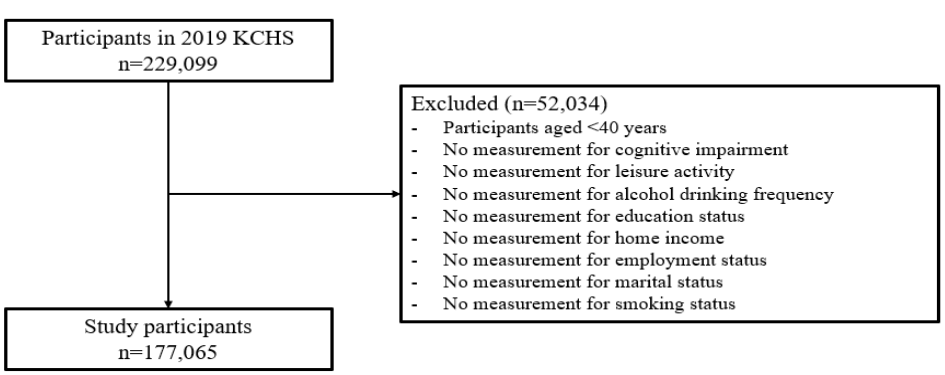

Figure 1. Study population (2019 Korea Community Health Survey)

Table 1. Baseline characteristics of study participants according to the leisure activity and alcohol drinking frequency*

Variables	Overall	Leisure activity, n (%)			Alcohol drinking frequency (times/month), n (%)				
		No	Yes	*p*-Value	Never	≤1	2-5	≥6	*p*-Value
Total	177,065 (100)	130,691 (67.0)	46,374 (33.0)		73,622 (33.7)	39,574 (24.5)	28,025 (19.2)	35,844 (22.6)	
Sex				<0.001					<0.001
Male	77,938 (48.4)	53,760 (62.4)	24,178 (37.6)		22,391 (22.6)	12,220 (17.3)	15,134 (22.8)	28,193 (37.3)	
Female	99,127 (51.6)	76,931 (71.4)	22,196 (28.6)		51,231 (44.1)	27,354 (31.3)	12,891 (15.9)	7,651 (8.7)	
Age				<0.001					<0.001
40-49	35,542 (29.3)	22,199 (60.3)	13,343 (39.7)		7,039 (17.9)	9,197 (26.2)	9,280 (27.2)	10,026 (28.7)	
50-59	43,649 (30.3)	28,655 (61.3)	14.994 (38.7)		12,738 (25.9)	11,497 (27.1)	8,803 (21.7)	10,611 (25.3)	
≥60	97,874 (40.4)	79,837 (76.3)	18,037 (23.7)		53,845 (51.1)	18,880 (21.4)	9,942 (11.5)	15,207 (16.0)	
Education				<0.001					
<High school	79,633 (29.6)	70,110 (85.3)	9,523 (14.7)		45,340 (52.9)	15,571 (21.5)	7,285 (10.1)	11,437 (15.6)	<0.001
High school	55,004 (35.3)	38,028 (67.3)	16,976 (32.7)		17,314 (28.4)	13,159 (25.1)	10,543 (20.1)	13,988 (25.9)	
>High school	42,428 (35.1)	22,553 (51.4)	19,875 (48.6)		10,968 (22.8)	10,844 (26.5)	10,197 (25.6)	10,419 (25.1)	
Home income				<0.001					<0.001
First quartile	66,081 (24.2)	57,266 (83.1)	8,815 (16.9)		38,059 (53.1)	12,275 (20.6)	6,097 (10.7)	9,650 (15.6)	
Second quartile	44,752 (24.9)	32,788 (70.2)	11,964 (29.8)		17,410 (35.2)	10,308 (24.3)	7,361 (18.3)	9,673 (22.2)	
Third quartile	23,046 (15.9)	15,596 (65.1)	7,450 (34.9)		7,108 (26.9)	5,764 (26.1)	4,611 (21.8)	5,563 (25.2)	
Fourth quartile	43,186 (35.0)	25,041 (54.6)	18,145 (45.4)		11,045 (22.3)	11,227 (26.6)	9,956 (24.6)	10,958 (26.5)	
Employment				<0.001					<0.001
Unemployed	69,485 (37.6)	54,490 (72.8)	14,995 (27.2)		39,542 (50.4)	14,657 (24.5)	7,417 (12.9)	7,869 (12.1)	
Employed	107,580 (62.4)	76,201 (63.6)	31,379 (36.4)		34,080 (23.6)	24,917 (24.5)	20,608 (23.0)	27,975 (28.9)	
Marital status				<0.001					<0.001
Married	130,003 (77.0)	31,603 (63.9)	38,400 (36.1)		48,765 (30.5)	30,095 (25.1)	22,246 (20.3)	28,897 (24.1)	
Divorced or widowed	40,173 (18.1)	34,120 (79.9)	6,053 (20.1)		22,743 (48.9)	8,019 (22.9)	4,310 (13.2)	5,101 (15.0)	
Single	6,889 (4.9)	4,968 (69.2)	1,921 (30.8)		2,114 (27.4)	1,460 (22.1)	1,469 (23.7)	1,846 (26.8)	
Smoking status				<0.001					<0.001
Never	109,280 (58.2)	82,818 (69.6)	26,462 (30.4)		55,059 (42.7)	29,076 (30.1)	15,029 (16.9)	10,116 (10.3)	
Past-smoker	40,069 (23.7)	27,789 (61.8)	12,280 (38.2)		12,805 (25.0)	6,562 (17.9)	7,588 (22.8)	13,114 (34.3)	
Current-smoker	27,716 (18.1)	20,084 (67.6)	7,632 (32.4)		5,758 (16.1)	3,936 (15.2)	5,408 (21.9)	12,614 (46.8)	

* Rao-Scott chi-square test was used to compare the baseline characteristics across the categorical variables. The percentage of each population was weighted.

Table 2. Baseline characteristics of study participants according to the mild cognitive impairment (MCI)

Variables	MCI, n (%)		
	Normal	Case	P-value
Total	139,630 (80.7)	37,435 (19.3)	
Sex			<0.001
Male	64,182 (84.1)	13,753 (15.9)	
Female	75,445 (77.5)	23,682 (22.5)	
Age			<0.001
40-49	31,532 (88.2)	4,010 (11.8)	
50-59	36,671 (83.7)	6,978 (16.3)	
≥60	71,427 (73.0)	26,447 (27.0)	
Education			<0.001
<High school	57,193 (71.6)	22,440 (28.4)	
High school	45,901 (83.2)	9,103 (16.8)	
>High school	36,536 (85.9)	5,892 (14.1)	
Home income			<0.001
First quartile	47,311 (71.7)	18,770 (28.3)	
Second quartile	36,282 (81.0)	8,470 (19.0)	
Third quartile	19,267 (83.8)	3,779 (16.2)	
Fourth quartile	36,770 (85.2)	6,416 (14.8)	
Employment			<0.001
Unemployed	50,380 (73.5)	19,105 (26.5)	
Employed	89,250 (85.0)	18,330 (15.0)	
Marital status			<0.001
Married	105,171 (82.3)	24,832 (17.7)	
Divorced or widowed	28,471 (72.0)	11,702 (28.0)	
Single	5,988 (87.2)	901 (12.8)	
Smoking status			<0.001
Never	84,582 (79.1)	24,698 (20.9)	
Past-smoker	31,784 (81.2)	8,285 (18.8)	
Current-smoker	23,264 (85.0)	4,452 (15.0)	
Leisure activity			<0.001
No	100,591 (78.7)	30,100 (21.3)	
Yes	39,039 (84.7)	7,335 (15.3)	
Alcohol drinking			<0.001
Never	55,166 (76.1)	18,456 (23.9)	
≤1time/month	31,429 (81.0)	8,145 (19.0)	
2-5times/month	23,402 (84.5)	4,623 (15.5)	
6≥times/month	29,633 (83.9)	6,211 (16.1)	

level, home income, employment status, marital status, and smoking status. Leisure activity was used as a covariate when observing the effects of alcohol drinking on MCI, and alcohol drinking frequency was used as a covariate when observing the effects of leisure activity on MCI. Education level was categorized as "none", "seodang/Chinese classics", "elementary school", "middle school", "high school", "college", "university", and "over university". We re-categorized education level variable into three groups: <high school (reference), high school, and >high school. Home income was available in the form of the amount of monthly income so that we categorized it into four quartiles groups. Marital status was categorized as either having a spouse if the respondent had a spouse, or having no spouse if the respondent was divorced, separated, widowed, or not married. Smoking status was coded as "smoking everyday", "smoking sometimes", "past smoking" and "never", and we re-categorized it as "never" (reference), "past-smoker", and "current-smoker".

Statistical analysis

The KCHS sample populations are derived from a sampling design with si/gun/gu as sampling units, and weights based on the structure of the sampling design are applied. All analyses were performed using complex samples considering the research design of the KCHS.

We used the Rao-Scott chi-square test to estimate the effects of variables on leisure activity and alcohol drinking frequency, and the data for each variable were presented as the number of participants and weighted percentage of the participants. Logistic regression analysis was also used to estimate the odds ratio (OR)for MCI. We constructed a single model adjusted for sex, age, education level, home income, employment status, marital status, and smoking status.

The joint effects of leisure activity and alcohol consumption on MCI were examined after adjusting for all covariates. We divided leisure activity variable into no leisure activity and leisure activity groups. Alcohol drinking frequency was divided into *<1time/month (low) and ≥1time/month (high)*. Then, we used the combinations of these categorical variables and classified them into the following four groups: *no leisure activity and low alcohol drinking frequency (reference), no leisure activity and high alcohol drinking frequency, leisure activity and low alcohol drinking frequency, and leisure activity and high alcohol drinking frequency* [11]. According to the recommendation of Knol and Vander-Weele, we calculated the additive scale (relative excess risk due to interaction, RERI) and the multiplicative scale (the ratio of ORs) [12].

Table 3. Odds ratios (ORs) for mild cognitive impairment (MCI) by leisure activity and alcohol drinking*

Variables	Crude OR (95% CI†)	Adjusted OR (95% CI†)
Leisure activity		
No	Reference	Reference
Yes	0.67 (0.65, 0.70)	0.88 (0.84, 0.91)
p for trend	<0.001	<0.001
Alcohol drinking frequency		
Never	Reference	Reference
≤1time/month	0.75 (0.72, 0.78)	1.05 (1.01, 1.10)
2-5times/month	0.58 (0.56, 0.61)	1.03 (0.97, 1.08)
≥6times/month	0.61 (0.59, 0.64)	1.09 (1.04, 1.15)
p for trend	<0.001	0.004

* Adjusted model was controlled for sex, age, education level, home income, employment status, marital status, smoking status, leisure activity status, and drinking frequency.
† CI, confidence interval

We computed 95% confidence interval (CI) to RERI, following the standard delta method based on a Taylor Series expansion [13].

All statistical analysis was performed using the SAS version 9.4 (SAS Institute Inc., Cary, NC, USA), and the statistical significance level for the two-sided test was set as 0.05.

Results

Participants' characteristics according to the leisure activity and frequency of alcohol drinking

There exist significant differences in the leisure activity status and alcohol drinking frequency by study participants' characteristics. Of overall 177,065 participants, the number and weighted percentage of no leisure activity and leisure activity were 130,691 (67.0%) and 46,347 (33.0%), respectively. The proportion of leisure activity group was higher for men than for women (p<0.001), and the proportion of that was decreased with age (p<0.001). The number and weighted percentage of never, ≤1time/month, 2-5times/month, and ≥6times/month alcohol drinking frequency were 73,622 (33.7%), 39,574 (24.5%), 28,025 (19.2%), and 35,844 (2.6%), respectively. The proportion of never alcohol drinking was higher for women than for men, while the proportion of ≥6times/month alcohol drinking was higher for men than for women (p<0.001). As age and home income increased, the proportion of ≥6times/month alcohol drinking was increased (both p<0.001) (Table 1).

Participants' characteristics according to the MCI

We found differences in MCI status by the study participants' characteristics. Among the total participants, 139,630 (80.7%) participants do not have MCI, and 37,435 (19.3%) people have MCI. The proportion of MCI cases in aged ≥60 years group was 27.0%, which was higher than younger aged group (p<0.001). MCI case tended to decrease with leisure activity (p<0.001), and with increasing alcohol drinking frequency (p<0.001) (Table 2).

ORs for MCI by leisure activity status and alcohol drinking frequency

The multiple logistic regression analysis showed ORs for MCI according to the leisure activity status and alcohol drinking frequency. After adjusting for all covariates, engaging in leisure activity decreased the prevalence of MCI by 0.88 (95% CI: 0.84, 0.91) times. With never alcohol drinking as a reference, MCI prevalence of ≤1time/month, 2-5times/month, and ≥6times/month alcohol drinking frequency group increased by 1.05 (95% CI: 1.01, 1.10) times, 1.03 (95% CI: 0.97, 1.08) times, and 1.09 (95% CI: 1.04, 1.15) times, respectively, and the trend was statistically significant (p=0.004) (Table 3).

Joint effects of leisure activity and alcohol drinking on MCI

We presented the joint effects of leisure activity and alcohol drinking on MCI under simultaneous exposure. Compared with the reference group (i.e. no leisure activity and low alcohol drinking frequency group), the OR for participants in leisure activity and high alcohol drinking group was 0.92 (95% CI: 0.87, 0.99), for the participants with a leisure activity and low alcohol drinking group was 0.84 (95% CI: 0.79, 0.90), and for the participants with no leisure activity and high alcohol drinking frequency group was 1.01 (95% CI: 0.96, 1.05). The RERI, which is an estimate of the interaction on the additive scale of leisure activity and alcohol drinking, was 0.08 (95% CI: -0.03, 0.18). Despite statistically insignificant on additive scale, the tendency of the observed additive effect of leisure activity and alcohol drinking was greater than the sum of each effects. There was a positive interaction on the multiplicative scale (OR=1.09), and the result was statistically significant (p=0.028) (Table 4)

Table 4. ORs* (95% confidence interval) for mild cognitive impairment (MCI) by joint effect between the leisure activity and alcohol drinking†

Variables	No leisure activity	Leisure activity	Leisure activity within Strata of alcohol drinking
Low alcohol drinking frequency	Reference	0.84 (0.79, 0.90)	0.84 (0.79, 0.90)
High alcohol drinking frequency	1.01 (0.96, 1.05)	0.92 (0.87, 0.99)	0.92 (0.86, 0.98)
Alcohol drinking frequency within strata of leisure activity	1.01 (0.96, 1.05)	1.10 (1.03, 1.16)	

Measurement of interaction on additive scale: RERI = 0.08 (-0.03, 0.18); p=0.154

Measurement of interaction on multiplicative scale: ratio of ORs = 1.09 (1.01, 1.17); p=0.028

* ORs, odds ratios

† Models were adjusted for age, sex, education level, home income, employment status, marital status, and smoking status.

Discussion

This study illustrates the individual and joint effects of the leisure activity and alcohol drinking on MCI using a representative sample of the Korea population in 2019 KCHS. Leisure activity decreased the OR for MCI, and increasing alcohol drinking frequency was associated with higher OR for MCI. In addition, we found that the effect of drinking alcohol on MCI depends on whether or not engaging in leisure activities. As alcohol drinking frequency increased, people engaging in leisure activity showed more increment of the OR for MCI than not engaging in it.

We controlled demographic variables that may act as a potential confounder. The differences between males and females in terms of neuropsychological functioning have been documented [14]. Age-related diseases accelerate the rate of neuronal dysfunction, neuronal loss, and cognitive decline [15]. The cognitive function also depends on education level in the direction that having more education was associated with better cognitive function [16, 17]. The study about significant trends of increasing mean cognitive performance with increasing income exists [17]. In addition, employment status and marital status are associated with cognitive performance [18, 19], and life time smokers tend to experience the cognitive decline larger with increasing number of pack-years smoked [20]. We, therefore, controlled these variables in statistical analysis, even though they are not the interest of our analysis.

Leisure activities had a protective effect against MCI in our study and this finding was consistent with other studies [3, 21, 22]. A cohort study conducted in China suggested that leisure activities in old age may protect against cognitive decline for both women and men, and different types of activities seem to benefit different cognitive domains [23]. Mental activity was associated with global cognition, language, and executive function; physical activity was associated with memory and language; and social activity was associated with global cognition [23]. Although the mechanism of these findings is not yet clear, there are some proposed hypothesis. Cognitive reserve is the most relevant mechanism which is based on more efficient utilization of brain networks or of enhanced ability to recruit alternate brain networks as needed [24]. According to this hypothesis, life experience may influence neural processing and synaptic organization by permitting neurological processes to become more efficient, adaptive, and plastic, thus allowing some people withstand progressing cognitive decline better than others. Leisure activities may also have beneficial effects through psychological and behavioral pathways by lowering stress, having a better diet, and healthier lifestyle, reducing the risk of worse cognitive function [25]. Active individuals are more likely to engage with others, leading to positive emotional states and lower

stress [26].

Present study found that alcohol drinking frequency is associated with MCI. There is an ongoing debate about the effect moderate alcohol drinking and the cognitive function. Some studies reported that the cognitive function decreased with alcohol drinking [27], while other studies reported that moderate alcohol drinking improved the cognitive function [28, 29]. One longitudinal prospective study insists that light alcohol consumption does not protect cognitive function [27]. The results from this study indicated that the observed benefits of moderate alcohol intake for cognitive function reported by others might occur due to a control group which is biased towards poor health, because people who have poor health tend to quit drinking alcohol. In contrary, a cohort study suggests that J-shaped relationship may exist between alcohol consumption and cognitive impairment [28]. That is, the cognitive functions of both heavy drinkers and abstainers decreased to a significantly greater degree during follow up than that of patients who consumed light-moderate alcohol. Our findings of insignificant OR for MCI by 2-5times/month alcohol drinking frequency corresponding to moderate alcohol consumption might be thought of as the reason that dose-response relationship between alcohol drinking and cognitive function is not yet clear like above (Table 3).

Interestingly, under the crude model, MCI prevalence decreased with increasing alcohol drinking frequency while; however, after adjusting for all covariates, the prevalence increased with increasing alcohol drinking frequency (Table 3). The proportion of ≥6times/month alcohol drinking frequency by age decreased from 28.7% to 25.3% and 16.0% at age 40-49 years, 50-59 years, and ≥60 years, respectively (Table 1). In addition, the proportion of MCI cases by alcohol drinking frequency decreased from 23.9% to 19.0%, 15.5%, and 16.1% at alcohol drinking frequency never, ≤1time/month, 2-5times/month, and ≥6times/month, respectively. Due to this evidence, in the crude model, the majority of older people belong to groups with a low frequency of alcohol drinking, so it can be assumed that the lower the frequency of alcohol drinking, the higher the MCI prevalence.

This study has several strengths. First, this is the first study to investigate the interaction of leisure activity and alcohol drinking on MCI in the Korean population. There is evidence that alcohol use was higher among individuals who spent more time involved in athletics and socializing [30]. Therefore, we investigated the interaction of these variables. Second, we focused on MCI, unlike most prior studies that investigated Alzheimer disease or dementia among cognition-related disease [5, 7]. Patients with MCI are at higher risk for developing Alzheimer disease with an estimated conversion of 10 to 15% per year [31]. Luis et al emphasized the need for uniformity in the use of instruments in epidemiologic studies to establish population estimates for diverse ethnic and cultural groups [32]. Finally, the 2019 KCHS data used in this study represent the general population in Korea; therefore, the above results can be generalized to the Korean population.

Nevertheless, the limitations of the present study should be considered. First, KCHS is a cross-sectional study so that we cannot draw inference for the causality between leisure activity, alcohol drinking and MCI. It would be necessary to use cohort or panel data to investigate the causal relationships between these variables in the future. However, given the benefits of leisure activity on health and the side-effects of alcohol drinking, it is hard to deduce a reverse relation logically. Secondly, MCI status was measured by relying on not a specialist's diagnosis but the participants' subjective answers, which is likely to lead to bias. Finally, there are some factors that affect cognitive function but could not be controlled in our study. Type 2 diabetes mellitus is an important risk factor for Alzheimer disease and dementia with interaction of other factors such as hypertension and dyslipidemia [33]. However, we could not use this variable because there is no division between type 1 and 2 diabetes in our database. There might also be cases where cognitive function was improved by medicine despite poor actual cognitive function. For these reasons, the MCI status may have been overestimated or underestimated. Follow up studies on MCI should consider the effects of these factors.

Conclusion

In conclusion, this study presented the evidence that engaging leisure activity is associated with increased cognitive function while higher alcohol drinking frequency decreased it. In addition, we observed the joint effects of leisure activity and alcohol drinking on mild cognitive impairment (MCI) when exposed simultaneously. The tendency of interaction on additive scale and multiplicative scale was the same, while only the latter was statistically significant. These results suggested that further studies need to investigate the interactions of leisure activity and alcohol drinking on cognitive function with cohort population.

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