


# BMJ Open Relationships between cognitive leisure activities and cognitive function in older adults with depressive symptoms: a cross-sectional study

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## ABSTRACT

**Objectives** The current study aimed to elucidate the associations between cognitive leisure activities and cognitive function in an older population stratified by having or not having depressive symptoms.

**Design** A retrospective cross-sectional study based on a self-report questionnaire.

**Setting** Annual health check-ups in a rural community in Japan.

**Participants** A total of 11 010 community-dwelling older adults aged  $\geq 65$  years (mean age:  $74.0 \pm 5.4$  years) was examined. Participants with missing data for the main outcome ( $n=1630$ ) were excluded.

**Outcome measures** Cognitive impairment was defined as at least 1.5 SD below the reference threshold (age-adjusted and education-adjusted score) on two of more of the tests in the National Center for Geriatrics and Gerontology-Functional Assessment Tool. Depressive symptoms were defined by a 15-item Geriatric Depression Scale score  $\geq 6$ . We assessed the frequency of participation in cognitive leisure activities using the validated scale (score: 0–42). A score of  $\geq 8$  points was defined as frequent participation in cognitive leisure activities.

**Results** A total of 12.6% ( $n=1186$ ) of the participants had depressive symptoms. There was a significant association between cognitive leisure activities and cognitive impairment in older adults (adjusted OR=0.77, 95% CI=0.65 to 0.94). In older adults with depressive symptoms, a higher frequency of cognitive leisure activities was negatively associated with cognitive impairment (adjusted OR=0.45, 95% CI=0.28 to 0.70). In contrast, there was no significant association in older adults without depressive symptoms (adjusted OR=0.85, 95% CI=0.70 to 1.02).

**Conclusions** Engaging in cognitive leisure activities in late life is associated with better cognitive function in older adults with depressive symptoms.

## INTRODUCTION

The prevention of cognitive decline in community-dwelling older adults is a crucial health concern as the population ages. The worldwide societal costs of dementia were estimated to be US\$818 billion in 2015, an increase of 35% since 2010, and a threshold

## Strengths and limitations of this study

- This is the first study to explore the association between cognitive leisure activities and cognitive function in Japanese older adults with depressive symptoms in a large number of participants.
- This study was unable to confirm any causal effects due to the retrospective cross-sectional study design.
- Cognitive impairment was assessed using a screening tool, and confirmatory diagnosis of cognitive disorders was not possible.
- Cognitive leisure activities and depressive symptoms were assessed by self-report questionnaires, raising concerns regarding recall bias.

of US\$1 trillion was crossed in 2018.<sup>1</sup> Given the high worldwide cost of dementia, it is important to prevent cognitive decline among older people, which leads to the onset of dementia. Depressive symptoms are associated with both cognitive decline and dementia.<sup>2–4</sup> Furthermore, depressive symptoms are associated with the development of Alzheimer's disease.<sup>5</sup> Prompt management of depressive symptoms could prevent further cognitive decline or be helpful for improving impaired cognition in older adults.

Emerging evidence indicates that cognitive leisure activities have a positive effect on both cognitive function and mental health, including depressive symptoms, among older people. A systematic review reported that participation in cognitively stimulating leisure activities may reduce the risk of dementia and cognitive impairment.<sup>6</sup> Similarly, leisure activities such as reading newspapers or books were found to be associated with a lower risk of depression in older adults.<sup>7</sup> However, it is still unclear whether cognitive leisure activities also have a positive impact on cognitive

function in community-dwelling older adults with depressive symptoms.

Therefore, we primarily aimed to clarify the association between cognitive leisure activities and cognitive function among older people in a large population-based cohort study. We also aimed to investigate the association between cognitive leisure activities and cognitive function in older adults according to the presence of depressive symptoms.

## MATERIALS AND METHODS

### Participants

We enrolled 11 010 community-dwelling older adults (aged  $\geq 65$  years) in the National Center for Geriatrics and Gerontology Study for Geriatric Syndromes (NCGG-SGS), a cohort study whose primary goal was to establish a screening system for geriatric syndromes in the Japanese community-dwelling population.<sup>8,9</sup> Participants were recruited from Nagoya and Obu, Japan. The inclusion criteria included residence in Obu (May 2013–June 2013 or February 2015–August 2016) or Nagoya at the time of examination (July 2013–December 2013). Meanwhile, the exclusion criteria were as follows: (1) history of neurological diseases such as depression, dementia, stroke and Parkinson's disease ( $n=1076$ ); (2) Mini-Mental

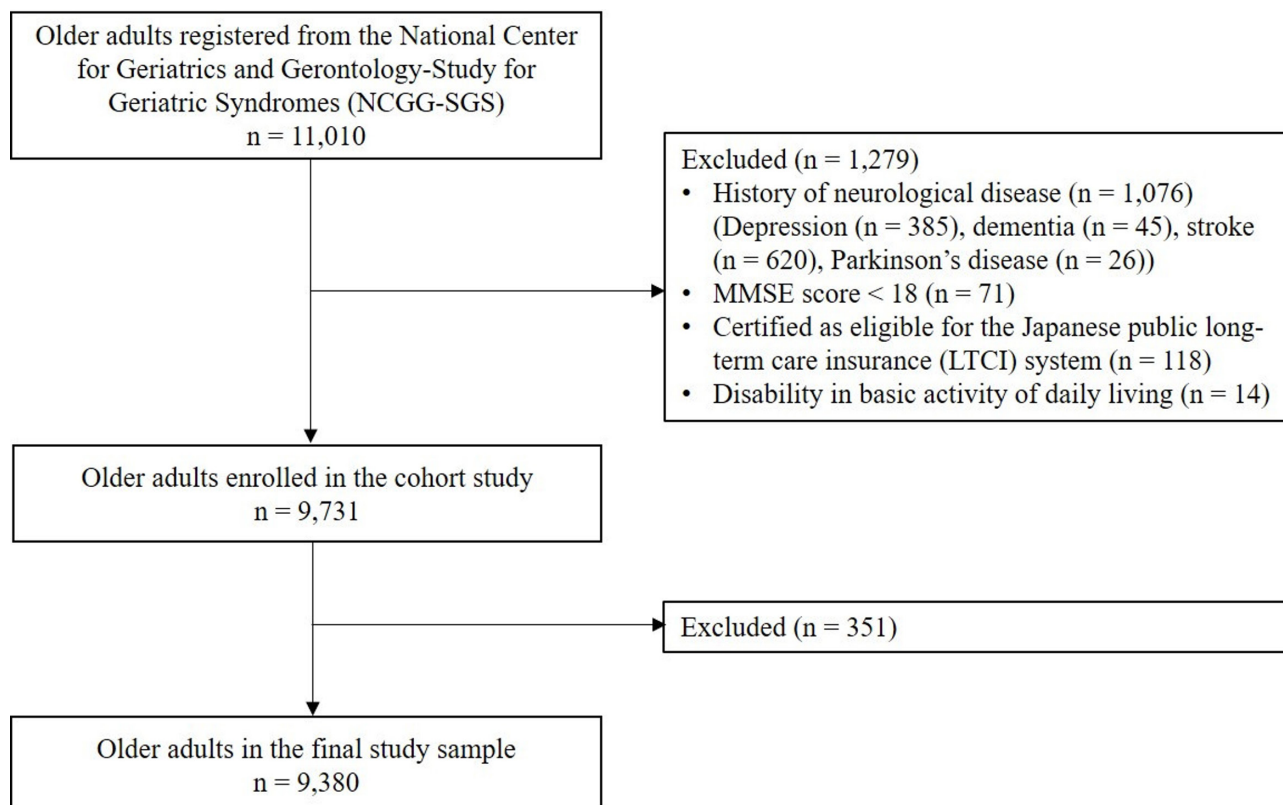
State Examination score of  $<18$  ( $n=71$ ); (3) requiring support or care according to the Japanese public long-term care insurance system ( $n=118$ ); (4) impaired performance in basic activities of daily living ( $n=14$ ); (5) missing outcome or missing data ( $n=351$ ). Finally, 9380 participants were included in this study (figure 1). Written informed consent was obtained from all participants in the study.

### Depressive symptoms

Depressive symptoms were assessed via the 15-item Geriatric Depression Scale (GDS). The participants responded with a 'yes' or 'no' to each item (range from 0 to 15), and the cut-off score was six points or higher.<sup>10</sup>

### Cognitive leisure activities

We assessed the frequency of participation in cognitive leisure activities using the cognitive activity scale.<sup>11</sup> This scale comprises six cognitive leisure activities commonly performed by older adults, namely, reading books or newspapers, writing for pleasure, doing crossword puzzles, playing board games or cards, participating in organised group discussions and playing musical instruments. Participants reported the frequency of participation as 'daily,' 'several days per week,' 'once weekly,' 'monthly,' 'occasionally' or 'never.' Total scores ranged from 0 to 42,



**Figure 1** The flow chart of this study consisted of one starting point (11 010 participants registered from NCGG-SGS), one middle point (9731 older adults were enrolled in this study) and one ending point (9380 participants were analysed in this study). Excluded older adults were identified between the starting point and middle point (1279 older adults) and between the middle point and ending point (351 older adults). MMSE, Mini-Mental State Examination; NCGG-SGS, National Center for Geriatrics and Gerontology Study for Geriatric Syndromes.

with higher scores indicating more frequent participation in cognitive activities. According to a previous study, the cut-off point was a score of 8 or higher.<sup>11</sup>

### Cognitive impairment

Cognitive function was measured using the NCGG-Functional Assessment Tool (FAT).<sup>12</sup> The NCGG-FAT consists of four domains: memory (word list memory-I (immediate recognition) and word list memory-II (delayed recall)), attention (an electronic table version of the Trail Making Test (TMT), TMT-part A), executive function (an electronic table version of the TMT-part B) and processing speed (an electronic table version of the Symbol Digit Substitution Test). High test-retest reliability and moderate to high validity of the NCGG-FAT have been confirmed in community-dwelling older adults.<sup>12</sup> Major cognitive impairment was defined as at least 1.5 SD below the reference threshold (age-adjusted and education-adjusted score) on two or more tests in the NCGG-FAT.

### Covariates

Age, sex, educational level, body mass index (BMI), employment status, current smoking habit, current alcohol use, grip strength and low back or knee pain were recorded as demographic data. Medication use was measured as the number of medications taken. Grip strength was measured in kilograms in the participant's dominant hand using a Smedley-type handheld dynamometer (GRIP-D; Takei, Niigata, Japan).<sup>13</sup>

### Statistical analyses

Student's t-test and Pearson's  $\chi^2$  test were used to test the differences in characteristics between participants with and without cognitive impairment. The objective variable was set as cognitive impairment, and the explanatory variable was frequent participation in cognitive leisure activities in the model. First, the relationship between cognitive impairment and cognitive leisure activities was examined using logistic regression analysis. We constructed two logistic regression models: a crude model and an adjusted model (adjusted for age, sex, educational level, BMI, employment status, medication use, current smoking habit, current alcohol use, grip strength, low back or knee pain and GDS score). We then examined the association between six cognitive leisure activities and cognitive impairment in community-dwelling older adults with and without depressive symptoms using logistic regression analysis.

Participants were classified by age into two categories: above 75 years of age or below 75 years of age. Educational level was classified as over 10 years or less than 10 years. BMI was classified as over 25 kg/m<sup>2</sup> or below 25 kg/m<sup>2</sup>. Employment status was classified as unemployed or employed. Current smoking habit was classified as current smoker or non-smoker. Current alcohol use was classified as current alcohol user or non-user. Low back and knee pain were classified as having pain or no pain.

A cut-off point of grip strength was used to determine whether participants were weak or strong, with a grip strength threshold based on previous studies of 26.0 kg in men and 18.0 kg in women.<sup>14</sup> Participants were then classified into those with and without depressive symptoms, and two logistic regression models were constructed: a crude model and an adjusted model (adjusted for age, sex, educational level, BMI, employment status, medication use, low back or knee pain, current smoking habit, current alcohol use, grip strength and low back or knee pain). The OR and 95% CI for the prevalence of maintaining cognitive function was estimated in each model using logistic regression analysis. All analyses were conducted using IBM SPSS Statistics V.24.0, and the level of significance was set at  $p < 0.05$ .

### PATIENT AND PUBLIC INVOLVEMENT

All participants in this study contributed their personal information to the research. Because this study was based on analysis of previously collected data, neither participants nor the public were involved in the design or planning of this study.

### RESULTS

The overall response rate was 26% (11 315/43 466). The partial response rates of the 2013 and 2015 Obu, and 2013 Nagoya samples were 26.2% (524/1997), 32% (5534/17 198) and 21.6% (5257/24 271), respectively. The cohort comprised 52.3% (n=4908) women, and the mean age of the participants was 74.0±5.4 years. The mean cognitive leisure activities score and GDS score were 10.9±5.5 and 2.6±2.6, respectively. Of the 9380 participants, 621 (6.6%) participants were classified as having cognitive impairment. Participants with cognitive impairment were significantly older, had lower levels of education, higher levels of unemployment and lower grip strength than those without cognitive impairment. Moreover, the number of current alcohol users among participants with cognitive impairment was lower than in those without. Importantly, participation in cognitive leisure activities, and GDS scores were lower among participants with cognitive impairment compared with those without (table 1).

Table 2 shows the results of the univariate and multivariate logistic regression models for investigating the association between cognitive impairment and cognitive leisure activities among the participants. Among the covariates, current alcohol use was most attenuated in the overall participants group (OR=0.80, 95% CI=0.67 to 0.95). Higher frequency of cognitive leisure activities had a significant negative association with cognitive impairment in both the crude model (OR=0.73, 95% CI=0.62 to 0.87) and the adjusted model (OR=0.77, 95% CI=0.65 to 0.94).

The association between the frequency of cognitive leisure activities and cognitive impairment among participants with and without depressive symptoms is shown

**Table 1** Comparisons of demographic and clinical variables in older adults with and without cognitive impairment

	Overall (n=9380)	Without cognitive impairment (n=8759)	With cognitive impairment (n=621)	P value
<b>Demographics</b>				
Age, mean (SD), years	74.0 (5.4)	73.9 (5.4)	75.3 (5.5)	<0.001
Sex, male, n (%)	4472 (47.7)	4171 (47.6)	301 (48.5)	0.708
Educational level, mean (SD), years	11.9 (2.5)	12.0 (2.6)	11.4 (2.4)	<0.001
BMI, kg/m <sup>2</sup>	23.1 (3.1)	23.1 (3.1)	22.8 (3.2)	0.011
Employment status, employed, n (%)	2368 (25.2)	2250 (25.7)	118 (19.0)	<0.001
Medication use, mean (SD)	3.0 (2.7)	3.0 (2.7)	3.1 (2.7)	0.338
Pain (low back or knee), yes, n (%)	3498 (37.3)	3284 (37.5)	214 (34.5)	0.144
Current smoker, n (%)	716 (7.6)	662 (7.6)	54 (8.7)	0.309
Current alcohol user, n (%)	4037 (43.0)	3807 (43.5)	230 (37.0)	0.002
Grip strength, mean (SD), kg	1.13 (0.23)	26.9 (7.70)	25.10 (7.83)	<0.001
Cognitive leisure activities score, mean (SD)	10.9 (5.5)	11.0 (5.5)	9.9 (5.6)	<0.001
GDS score, mean (SD)	2.6 (2.6)	2.6 (2.6)	3.0 (2.7)	<0.001

All p values were generated from Student's t-test or  $\chi^2$  test.  
BMI, body mass index; GDS, Geriatric Depression Scale.

in table 3. Among the covariates, current alcohol use was most attenuated in both groups (without depressive symptoms: OR=0.83, 95% CI=0.69 to 1.00; with depressive symptoms: OR=0.63, 95% CI=0.38 to 1.02). Among participants with depressive symptoms, the frequency of cognitive leisure activities had an independent negative association with cognitive impairment in both the crude model (OR=0.45, 95% CI=0.29 to 0.70) and the adjusted model (OR=0.45, 95% CI=0.28 to 0.70). In contrast, among participants without depressive symptoms, there

was no significant association in the adjusted model (OR=0.85, 95% CI=0.70 to 1.02), while the frequency of cognitive leisure activities had an independent negative association with cognitive impairment in the crude model (OR=0.82, 95% CI=0.68 to 0.99).

Table 4 shows the associations between six cognitive leisure activities and cognitive impairment in older adults. Among these cognitive leisure activities, reading books or newspapers, writing for pleasure, doing crossword puzzles and playing board games or cards were significantly

**Table 2** Association between cognitive leisure activities and cognitive impairment in older adults

	Crude		Adjusted model	
	OR (95% CI)	P value	OR (95% CI)	P value
Frequent cognitive leisure activities (reference: infrequent)	0.73 (0.62 to 0.87)	<0.001	0.77 (0.65 to 0.94)	0.006
Age (reference $\leq 74$ years)			1.09 (0.88 to 1.26)	0.593
Male (reference female)			1.14 (1.71 to 2.85)	<0.001
Educational level (reference $\leq 9$ years)			0.94 (0.79 to 1.14)	0.558
BMI (reference $\leq 25$ kg/m <sup>2</sup> )			0.96 (0.81 to 1.22)	0.974
Employment status (reference: employed)			1.33 (1.08 to 1.65)	0.008
Medication use			0.99 (0.95 to 1.02)	0.344
Current smoking habit (reference: not current smoker)			1.17 (0.83 to 1.53)	0.445
Current alcohol use (reference: not alcohol user)			0.80 (0.67 to 0.95)	0.013
Grip strength (reference: high grip strength)			1.81 (1.50 to 2.18)	<0.001
Pain (reference: not having low back or knee pain)			0.85 (0.71 to 1.02)	0.072
GDS score			1.04 (1.00 to 1.07)	0.032

The objective variable was cognitive impairment, and the explanatory variable was frequent cognitive leisure activities. Except for GDS score and medication use, all of the variables were dichotomised. Cognitive leisure activities: frequent or infrequent; age: above 75 years or below; educational level: over 10 years or below; BMI: over 25 kg/m<sup>2</sup> or below; employment status: unemployed or employed; smoking, drinking: current or none; grip strength; low or high; pain: having low back or knee pain or not having pain. BMI, body mass index; GDS, Geriatric Depression Scale.

**Table 3** Association between cognitive leisure activities and cognitive impairment in older adults with and without depressive symptoms

	Without depressive symptoms		With depressive symptoms	
	OR (95% CI)	P value	OR (95% CI)	P value
Frequent cognitive leisure activities (reference: infrequent)	0.85 (0.70 to 1.02)	0.085	0.45 (0.28 to 0.70)	<0.001
Age (reference: ≤74 years)	1.09 (0.90 to 1.33)	0.367	1.16 (0.73 to 1.87)	0.530
Male (reference: female)	1.14 (0.94 to 1.38)	0.180	1.15 (0.73 to 1.81)	0.550
Educational level (reference: ≤9 years)	0.88 (0.72 to 1.08)	0.215	1.20 (0.76 to 1.91)	0.435
BMI (reference: ≤25 kg/m <sup>2</sup> )	0.96 (0.77 to 1.20)	0.727	0.96 (0.56 to 1.63)	0.877
Employment status, (reference: employed)	1.25 (1.00 to 1.56)	0.052	2.38 (1.16 to 4.89)	0.018
Medication use	1.00 (0.96 to 1.03)	0.996	0.97 (0.90 to 1.05)	0.437
Current smoking habit (reference: not current smoker)	1.14 (0.81 to 1.59)	0.461	1.44 (0.71 to 2.93)	0.310
Current alcohol use (reference: not alcohol user)	0.83 (0.69 to 1.00)	0.053	0.63 (0.38 to 1.02)	0.058
Grip strength (reference: high grip strength)	1.76 (1.43 to 2.17)	<0.001	2.18 (1.38 to 3.44)	0.001
Pain (reference: not having low back or knee pain)	0.85 (0.70 to 1.04)	0.112	0.89 (0.57 to 1.38)	0.589

The objective variable was cognitive impairment, and the explanatory variable was frequent cognitive leisure activities. Except for medication use, all the variables were dichotomised. Cognitive leisure activities: frequent or infrequent; age: above 75 years or below; educational level: over 10 years or below; BMI: over 25 kg/m<sup>2</sup> or below; employment status: unemployed or employed; smoking, drinking: current or none; grip strength; low or high; pain: having low back or knee pain or not having pain. BMI, body mass index.

associated with cognitive impairment in both the crude and adjusted models (all  $p < 0.05$ ) (table 4). Table 5 shows the associations between six cognitive leisure activities and cognitive impairment, between two groups. Among older adults without depressive symptoms, the frequency of doing crossword puzzles and playing board games was associated with better cognitive function (all  $p < 0.05$ ), whereas the frequency of participating in crossword puzzles and organised group discussions was associated with better cognitive function in older adults with depressive symptoms (all  $p < 0.05$ ) (table 5).

In another subanalysis (not displayed as a table), the frequency of cognitive leisure activities among participants with and without depressive symptoms was compared via a  $\chi^2$  test. A total of 54.0% (641) and 68.1% (5580) of

participants with and without depressive symptoms exhibited a higher frequency of cognitive leisure activities, respectively. Moreover, 46.0% (545) and 31.9% (2614) of participants with and without depressive symptoms had a lower frequency of cognitive leisure activities. GDS scores were significantly associated with the frequency of cognitive leisure activities ( $p < 0.001$ ).

## DISCUSSION

### Key results

The current cross-sectional large-population study revealed a prevalence rate of 12.6% for depressive symptoms among Japanese community-dwelling older adults. A higher frequency of cognitive leisure activities

**Table 4** Association between cognitive leisure activities and cognitive impairment in older adults

	Crude		Adjusted model*	
	OR (95% CI)	P value	OR (95% CI)	P value
Cognitive leisure activities				
Reading books or newspapers (reference: infrequent)	0.74 (0.57 to 0.96)	0.023	0.76 (0.59 to 1.00)	0.047
Writing for pleasure (reference: infrequent)	0.80 (0.67 to 0.96)	0.015	0.80 (0.68 to 0.96)	0.016
Doing crossword puzzles (reference: infrequent)	0.57 (0.47 to 0.96)	<0.001	0.59 (0.48 to 0.72)	<0.001
Playing board games or cards (reference: infrequent)	0.66 (0.45 to 0.97)	0.034	0.66 (0.45 to 0.98)	0.037
Participating in organised group discussions (reference: infrequent)	0.86 (0.72 to 1.04)	0.130	0.89 (0.74 to 1.08)	0.247
Playing musical instruments (reference: infrequent)	0.85 (0.59 to 1.24)	0.404	0.89 (0.61 to 1.30)	0.560

The objective variable was cognitive impairment, and the explanatory variable was six cognitive leisure activities.

\*Adjusted for age, sex, educational level, BMI, employment status, medication use, current smoking habit, current alcohol use, grip strength, pain and GDS score. Except for medication use, all the variables were dichotomised. BMI, body mass index; GDS, Geriatric Depression Scale.

**Table 5** Association between cognitive leisure activities and cognitive impairment in older adults with and without depressive symptoms

	Without depressive symptoms*		With depressive symptoms*	
	OR (95% CI)	P value	OR (95% CI)	P value
<b>Cognitive leisure activities</b>				
Reading books or newspapers (reference infrequent)	0.81 (0.60 to 1.10)	0.175	0.65 (0.37 to 1.14)	0.134
Writing for pleasure (reference: infrequent)	0.84 (0.69 to 1.02)	0.081	0.59 (0.34 to 1.02)	0.060
Doing crossword puzzles (reference: infrequent)	0.60 (0.48 to 0.74)	<0.001	0.55 (0.32 to 0.95)	0.032
Playing board games or cards (reference: infrequent)	0.66 (0.43 to 0.99)	0.047	0.74 (0.26 to 2.15)	0.585
Participating in organised group discussions (reference: infrequent)	0.98 (0.80 to 1.20)	0.844	0.34 (0.14 to 0.79)	0.013
Playing musical instruments (reference: infrequent)	0.93 (0.63 to 1.37)	0.697	0.65 (0.15 to 2.81)	0.566

The objective variable was cognitive impairment, and the explanatory variable was six cognitive leisure activities.

\*All models were adjusted for age, sex, educational level, BMI, employment status, medication use, current smoking habit, current alcohol use, grip strength, pain, and GDS score. Except for medication use, all of the variables were dichotomised. BMI, body mass index.

was negatively associated with cognitive impairment in community-dwelling older adults. In addition, the frequency of cognitive leisure activities was negatively associated with cognitive impairment in older adults with depressive symptoms.

### Cognitive impairment and depressive symptoms

Our results revealed that older adults with cognitive impairment had higher GDS scores than those without. The relationships between depressive symptoms and cognitive disorder are complex. Cognitive impairment was concurrent with late-life depression, which affected performance across various cognitive domains.<sup>15</sup> In addition, depressive symptoms were risk factors for developing AD, even in individuals in whom the first depressive symptoms occurred more than 25 years before the onset of AD.<sup>5</sup> These findings suggest that cognitive function and depression/depressive symptoms may have a bidirectional association. In a previous study, Goveas *et al* suggested that depressive symptoms and memory functions had interactive effects on the hippocampal functional connectivity.<sup>16</sup> Many epidemiological studies have reported a link between depressive symptoms and cognitive decline.<sup>2-4</sup> Similar to previous studies, the current study revealed a strong association between depressive symptoms and cognitive function. Our results suggest that depressive symptoms are associated with the risk of cognitive functional decline,<sup>17-19</sup> whereas one study reporting that depression is a symptom of subjective cognitive decline.<sup>20</sup> However, this study did not focus on older adults, and cognitive impairment was not assessed objectively. Further research is needed to determine the relationship between depression and cognitive impairment in older adults.

### Cognitive leisure activities and cognitive impairment in older adults

Several previous studies reported that active participation in cognitive leisure activities in late life may be beneficial

for preventing the risk of dementia among elderly individuals.<sup>21</sup> Furthermore, previous cross-sectional studies<sup>22 23</sup> and longitudinal studies<sup>6 24</sup> have shown that cognitive leisure activities are beneficial for cognitive function among community-dwelling older adults. Our results confirm that more engagement in cognitive leisure activities was associated with less cognitive impairment in community-dwelling Japanese older adults. Specifically, frequently reading books and newspapers, writing for pleasure, doing crossword puzzles and playing board games were associated with less cognitive impairment. Frequent participation in leisure activities, such as reading newspapers or books and engaging in outdoor building projects, has previously been reported to be associated with a lower risk of depression relative to low participation in leisure activities.<sup>7</sup> Moreover, participation in cognitive activities involving games and puzzles is reported to be related to better cognitive abilities and lower volumes in Alzheimer Disease (AD)-vulnerable brain structures.<sup>25</sup> The current results, using a leisure activity scale, are in accord with these previous findings. However, the mechanisms underlying the association between leisure activities and cognitive function are currently unclear. One potential explanation is that leisure activities influence neural processing and synaptic organisation by enabling neurological processes to become better at coping with progressing dementia pathology.<sup>26</sup> Further research is needed to clarify these mechanisms.

### Cognitive leisure activities and cognitive impairment in older adults with depressive symptoms

In the current study, we performed stratified analyses for older adults with and without depressive symptoms. Two previous studies suggested that late-onset depression may be associated with more cognitive impairment than early-onset depression.<sup>18 19</sup> As mentioned above, the causal relationship between depression and cognitive impairment is considered to be complex, but interventions

targeting older adults with depressive symptoms may have the potential to help maintain cognitive health.<sup>4</sup> In the current results, higher engagement in cognitive leisure activities was negatively associated with cognitive impairment in older adults with depressive symptoms. Playing board games was associated with less cognitive impairment in older adults without depressive symptoms. It has been reported that board game players have a 15% lower risk of developing dementia than non-players.<sup>22</sup> The current results are consistent with these previous studies. In addition, participating in organised group discussions was associated with less cognitive impairment in older adults with depressive symptoms. In accord with this finding, interpersonal communication was previously found to be correlated with social self-efficacy,<sup>27</sup> and self-efficacy was negatively associated with depressive symptoms.<sup>28</sup> Older adults with a socially integrated lifestyle might have more opportunities to engage with others, leading to positive emotional states, including social competence, consequently leading to less stress.<sup>29</sup> In the current study, group discussion, as a form of frequent interaction to achieve a set of goals, was associated with cognition in older adults with depressive symptoms. Cognitive leisure activities might alleviate depressive symptoms that accelerate cognitive impairment, and this could result in delayed cognitive impairment. In future, longitudinal research will be needed to determine the associations between cognitive function, cognitive leisure activities and depression among older adults with depressive symptoms. Leisure activities may protect people against cognitive impairment through synergistic effects. In accord with this notion, cognitive leisure activities were both directly and indirectly associated with cognitive function via depressive symptoms in the current study. Moreover, cognitive leisure activities were not associated with cognitive impairment among older adults without depressive symptoms. Differences in engagement in cognitive activities could potentially explain this finding, with a higher proportion of participants exhibiting more engagement in cognitive leisure activities in older adults without depressive symptoms compared with those with depressive symptoms.

### Limitations of this study

Several limitations of the current study should be noted. First, we used a cross-sectional design. Thus, it was not possible to draw conclusions about the effectiveness of cognitive leisure activities in the management of depressive symptoms. The causal relationships between cognitive leisure activities and cognitive function should be clarified in a prospective study in future. Although we were unable to clarify the causal relationships between depressive symptoms and cognitive impairment, the current results highlight the importance of managing older adults with depressive symptoms in terms of cognitive preservation. This is particularly important because depressive symptoms are a stronger risk factor for community-dwelling older adults and are associated with an increased risk

of incident dementia and Alzheimer's disease in older adults over a long period of time.<sup>17</sup> Second, participants were not randomly recruited. Rather, we recruited relatively healthy elderly persons who were able to receive health check-ups. Third, the cognitive leisure activities and depressive symptoms used for the analyses were based on a self-report questionnaire, increasing the possibility of recall bias. Fourth, owing to the limitations of the questionnaires, the analysis only included six cognitive leisure activities. The specific contribution of many common cognitive leisure activities to overall cognitive health during ageing remains unclear.<sup>30</sup> Fifth, we did not investigate whether participants were taking antidepressants. We only investigated the number of medications taken based on the previous finding that polypharmacy increased cognitive impairment even after controlling for the effects of comorbidities and other confounding variables.<sup>31</sup> Finally, we did not examine cognitive functions other than memory, attention, executive function and processing speed. However, the NCGG-FAT assessment is considered a reliable and valid tool for Japanese adults aged 65 years or older.<sup>12</sup> We measured cognitive impairment using the NCGG-FAT because it is a specialised assessment system for evaluating multidimensional neurocognitive function in large populations of older adults.<sup>12</sup> The current study revealed that more frequent cognitive leisure activities were negatively associated with cognitive impairment in older adults with depressive symptoms. The main strength of the current study was its large sample size and the comprehensive nature of our assessments. Future studies with a prospective design will enable the causal relationships between cognitive leisure activities and cognitive impairment in older adults with depressive symptoms to be addressed.

### CONCLUSION

In conclusion, frequent participation in cognitive leisure activities was associated with lower levels of cognitive impairment in older adults with depressive symptoms, whereas no significant associations were found in older adults without depressive symptoms. These findings support the hypothesis that cognitive leisure activities are associated with a decreased risk of cognitive impairment in older adults with depressive symptoms.

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