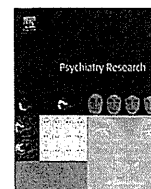




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## Factor structures of a Japanese version of the Geriatric Depression Scale and its correlation with the quality of life and functional ability



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### ARTICLE INFO

#### Article history:

Received 15 April 2013

Received in revised form

5 November 2013

Accepted 4 December 2013

Available online 18 December 2013

#### Keywords:

Depression

Geriatric Depression Scale (GDS-15)

Factor analysis

Activities of daily living (ADLs)

Quality of life (QOL)

Cognitive function

### ABSTRACT

We investigated the 15-item Geriatric Depression Scale (GDS-15) with regard to its factors and reproducibility, as well as its relationship to activities of daily living, social factors, medical conditions, and quality of life for community-dwelling elderly people in Japan. The study population consisted of 736 community-dwelling elderly participants aged 65 or older. Exploratory factor analysis of the data and correlation coefficients between factors and activities of daily living, quality of life, social factors, and medical conditions were calculated for two consecutive years. The reproducibility of the results was also evaluated. As the result, GDS-15 had three reproducible factors specified as follows: factor I, "energy loss and pessimistic outlook"; factor II, "positive mental status (reversed)"; and factor III, "empty feeling." Comparing our findings with a review of research in this area, positive items (excluding "feel full of energy") seem to compose a universal factor. Factor I correlated best with quality of life, factor II with activities of daily living, and factor III with subjective cognitive function. These results suggest the GDS-15 can be used to assess the functional ability and quality of life, as well as depressive mood in older adults.

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### 1. Introduction

Depressive mood is a multifaceted phenomenon involving loss of hope, satisfaction, energy, and interest. It is often accompanied by feelings of boredom, worthlessness, helplessness, and a loss of interest in activities. Many questionnaires have been developed to identify pathological depressive mood. Most of these questionnaires identify depressive mood using a sum of the reported symptoms. However, individual symptoms have been shown to have different qualities. Studies analyzing the Center for Epidemiologic Studies Depression Scale indicate that the loss of a positive affect does not always indicate equal negative affects (Iwata et al., 1998; Jang et al., 2010). Studies on the 15-item Geriatric Depression Scale (GDS-15) reveal that positive psychological affects, specifically the satisfaction

with life, happiness, and energy may have a favorable effect on the maintenance of functional ability, regardless of the negative effects (Hirosaki et al., In press). The diagnostic criteria of major depression also considered the different quality of symptoms such as those observed in melancholic feature seen in the patients suffering from major depression (American Psychiatric Association, 2000). Accordingly, the factors attributing to depressive mood in questionnaires are as important as the simple summation of symptoms.

The GDS-15 is a self-administered depression questionnaire for elderly people, which omits the non-specific physical symptoms that frequently occur among elderly populations (Yesavage et al., 1982). The factor structure of the GDS-15 and its relation to functional disability has been investigated in previous studies. A meta-analysis of the factor structures of versions in different languages found the English and Chinese versions have four factors each, while the Korean version has six (Kim et al., 2012). The items making up these factors also differ by language. For example, the factor "Positive Mood" is commonly composed of the items "satisfied with life," "good spirits," "happy most of the time,"

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and “wonderful to be alive now” are common in the English and Korean versions, meanwhile the items composing this factor in the Chinese version are “good spirits,” “helpless feeling,” and “energy loss” (Kim et al., 2012). The Korean version additionally includes the items “energy loss” and “hopeless situation” (Kim et al., 2012). For the factor of “Dysphoria”, the only item in common among English, Chinese, and Korean versions was “bored feeling”. “Worthless feeling” appears in both English and Chinese versions, and “empty feeling” and “afraid that something will happen” appears in both Chinese and Korean versions. Three and two other items are included in the “Dysphoria” factor in English and Chinese versions, respectively (Kim et al., 2012). The “Social Withdrawal-Apathy-Cognitive Impairment” factor has three items in common between the English and Chinese versions: “dropped interests,” “preference to stay at home,” and “memory problems”, “afraid that something bad will happen” only appears in the English version (Kim et al., 2012).

On the basis of this lack of agreement, researchers concluded that these differences may stem from cultural differences in the conceptualization and expression of depressive symptoms (Kim et al., 2012). However, culture and language do not appear to explain all of this disagreement. Although there have been four studies on the factor structure of the Japanese version, results are contradictory, with the number of factors ranging from two to four (Onishi et al., 2006, 2004; Schreiner et al., 2003; Yatomi, 1994). Common items composing one factor are “satisfied with life,” “good spirits,” “happy most of the time,” and “wonderful to be alive now,” and other common items composing another factor are “empty”, “bored” feeling and “afraid that something bad will happen”. None of the other items are common.

In light of these heterogeneous results both between and within languages and cultures, two questions must be asked. The first is whether there are indeed any stable factors: the second is what meaning such factors might have, given strong cultural and linguistic differences in how depression is defined and experienced.

With regard to reproducibility, most of the studies (Chiu et al., 1994; Incalzi et al., 2003; Brown et al., 2007; Salamero and Marcos, 1992) were not able to reproduce a factor, with the number of reported factors within the same language ranging from two to nine (Kim et al., 2012). Even in instances for which the reported number of factors was the same, the items composing the factors were often different (Kim et al., 2012). This indicates that the factors presented in these studies are not reproducible: some of the aforementioned studies performed confirmatory analyses, which can assess the goodness-of-fit, but not the reproducibility of composite factors.

Even if factors were found to be reproducible across languages and cultures, practical meanings of such factors is still unclear. To our knowledge, although there have been two studies on the relationship between the factors of the GDS-15 and functional disabilities, including basic activities of daily living (BADLs) and instrumental activities of daily living (IADLs) (Onishi et al., 2006, 2004), there have been no studies on the relationship between quality of life (QOL) and the factors of the GDS-15, which should represent the true outcome regarding the depression scale. Therefore, the aims of this study are (1) to investigate the reproducibility of the factor structure of the GDS-15 and (2) to explore its relationship to health-related variables such as QOL, as well as to physical and social variables.

## 2. Methods

### 2.1. Participants

The study was conducted in 2005 and 2006, and the study population consisted of 736 community-dwelling participants aged 65 or older

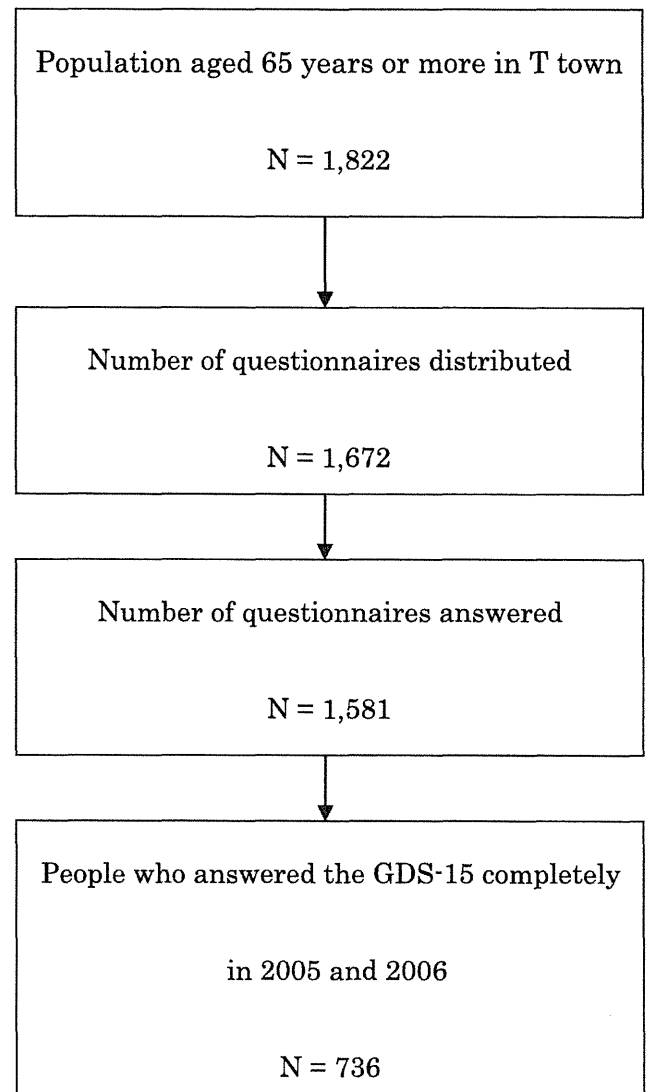


Fig. 1. Participant selection and determination during 2005–2006.

(M:F=406:330, mean age [S.D.] = 74.3 [6.6]) living in Tosa (town), Japan. Health questionnaires were distributed by the local government and returned by mail.

T town is situated in the central region of Shikoku, which is the smallest and least populous of Japan's 4 main islands. Its primary industries are agriculture and forestry. During the study period, the town had a population of 4851, with 1822 (37.6%) residents aged 65 years or older.

Participants included in the study were those who answered the GDS-15 without omissions in the consecutive years; participants with omissions in one or both years (53%) were excluded from the study. Fig. 1 illustrates the participant selection procedure.

### 2.2. Instrument

#### 2.2.1. Geriatric Depression Scale-15

The GDS-15 is a validated depression scale comprising 15 items. It was developed to exclude the effects of non-specific somatic symptoms such as anorexia and insomnia, which are frequently observed among elderly populations (Yesavage et al., 1982; Sheikh, 1986). Each item can have 2 answers, i.e., yes or no; the highest possible score is 15, which indicates the most severe depressive state. Using a cut-point of 5 or more, the original version of GDS-15 has a sensitivity of 97% and a specificity of 95%, compared with the results of structured clinical interviews for the determination of depression (Nyunt et al., 2009). We used the Japanese version of the GDS-15 in our study (Nimo et al., 1991). Its sensitivity and specificity using the cut-point of 5 or more was reported to be 97.3% and 95.9%, respectively (Schreiner et al., 2003).

### 2.2.2. Activities of daily living

Each subject rated his or her independence with respect to 7 items corresponding to basic activities of daily living (BADL). Specifically, these items were as follows: walking, ascending and descending stairs, feeding, dressing, going to the toilet, bathing, and grooming. Each BADL item was evaluated based on 4 levels of competence: 3, completely independent; 2, requiring some assistance; 1, requiring much assistance; 0, completely dependent. The scores for the 7 BADL were summed to a total score (0–21) (Matsubayashi et al., 1996).

For advanced ADLs, the Tokyo Metropolitan Institute of Gerontology Index of Competence rating scale (0–13) was used to measure competence (Nyunt et al., 2009; Niino et al., 1991). This scale quantifies instrumental self-maintenance (0–5), intellectual activity (0–4), and social roles (0–4). This assessment consists of a 13-item index including 3 sublevels of competence (Ishizaki et al., 2000; Koyano et al., 1991): (i) instrumental ADL (5 items: the ability to use public transport, buy daily necessities, prepare a meal, pay bills, and handle banking matters; each rated as “yes” or “no”); (ii) intellectual activities (4 items: the ability to complete forms, read newspapers, read books or magazines, and show interest in television programs or news articles on health-related matters; each rated as “yes” or “no”); and (iii) social roles (4 items: the ability to visit friends, give advice to relatives and friends in confidence, visit someone at the hospital, and initiate conversation with younger people; each rated as “yes” or “no”).

### 2.2.3. Quality of Life (QOL)

QOL was assessed using a 100 mm visual analog scale (VAS) (Morrison, 1983; Matsubayashi et al., 1997) with the poorest QOL on the left end of the scale and the best on the right end. This was assessed using five items that subjectively rated health, relationships with family, relationships with friends, financial status, and happiness. The inter-rater reliability and test-retest reliability of the VAS were 0.74 and 0.82, respectively (Matsubayashi et al., 1994). QOL measured by VAS has good validity and reliability, as well as moderate distribution-based responsiveness and good anchor-based responsiveness as compared to multi-item questionnaire (de Boer et al., 2004).

### 2.2.4. Cognitive function

Cognitive function was subjectively assessed and ranked using an 8-level scale developed for the Nursing Care Insurance Program by the Japanese Ministry of Health, Labor and Welfare. The scale is ranked as follows: 0, having no cognitive impairment; 1, having slight cognitive impairment but being independent without help in daily life; 2, having mild cognitive impairment but being independent with someone's attention, which is seen mainly outside the house; 3, having mild cognitive impairment but being independent with someone's attention, which is seen also in the house; 4, having cognitive impairment and requiring care, which is seen mainly during the day; 5, having cognitive impairment and requiring care, which is seen mainly at night; 6, having cognitive impairment and requiring continuous care; 7, having cognitive impairment with severe behavior disorder requiring medical care (Japanese Ministry of Health LaW, 2009). Participants ranked as 0 and 1 were considered to be independent with respect to subjective cognitive function.

### 2.2.5. Socio-demographic information

Socio-demographic variables including age, sex, years of education, loss of partner, and living alone, which are known to be risk factors for the development of major depression, were assessed (Lehtinen and Joukamaa, 1994; Cole and Dendukuri, 2003).

## 2.3. Analysis

Statistical analysis was performed using IBM SPSS ver. 20.0 and AMOS ver. 20.0.0 (IBM Inc., Armonk, NY). Exploratory factor analysis using the maximum likelihood analysis with varimax rotation was conducted on the 15 items of the GDS-15. Items with a factor loading of 0.3 or greater were considered to contribute to the factor. If there were items with multiple loadings of 0.3 or greater, the factor with the greatest loading score was considered to be contributed by the items. Cronbach's alpha was calculated for both the GDS-15 as a whole and for each composite factor. Confirmatory factor analysis that defined factors as latent variables and items belonging to the factors as observable variables was conducted to show the stability of factors in terms of goodness-to-fit index (GFI). Correlation coefficients were calculated using Pearson's method and Spearman's method for parametric and nonparametric variables, respectively. Significance was set at 0.05 for all analysis.

## 3. Results

Table 1 shows the basic socio-demographic characteristics of the participants. In 2005, the mean age (SD) of the participants

**Table 1**

Basic demography, mental state, quality of life, activities of daily living, and medical conditions.

	T town 2005 (n=736)
Age, mean (S.D.)	74.3 (6.6)
Male (%)	55.2
Loss of partner (%)	28.4
Living alone (%)	12.8
Depressive mood and cognitive function	
GDS-15 score, mean (SD)	4.7 (3.9)
Independence in subjective memory function, %	96.0
VAS QOLs (0–100), mean (S.D.)	
Family relationship	79.1 (20.2)
Friend relationship	75.7 (21.0)
Financial satisfaction	55.4 (24.4)
Subjective health	59.4 (22.2)
Subjective happiness	66.2 (22.1)
ADLs	
Basic ADL (0–21), mean (S.D.)	20.1 (2.8)
Instrumental ADL (0–5), mean (S.D.)	4.4 (1.3)
Intellectual activity (0–4), mean (S.D.)	3.1 (1.1)
Social role (0–4), mean (S.D.)	3.2 (1.2)
Past and present illness (%)	
Diabetes mellitus	8.4
Hypertension	56.9
Stroke	9.5
Cardiovascular disease	11.2
Osteoarthritis	24.9

GDS-15: 15-item Geriatric Depression Scale; VAS: Visual Analogue Scale; ADL: Activities of Daily Living.

was 74.3 (6.6) years, and the percentage of male participants in Tosa (town) was 55.2% (n=736). The mean BADL score (S.D.) was 20.1 (2.8), indicating that the participant group was almost entirely independent.

Table 2 shows the results of factor analysis in Tosa (town) during 2005 and 2006. A maximum likelihood analysis was conducted on the 15 items with varimax rotation for the respective data in 2 samples. The Kaiser–Meyer–Olkin measure verified the sampling adequacy for the analysis (KMO=0.91 and 0.92 for T town 2005 and T town 2006, respectively), and all KMO values for individual items were greater than 0.5. Bartlett's test of sphericity ( $\chi^2(105)=3303.81$ ,  $\chi^2(105)=4178.14$  for T town 2005 and T town 2006, respectively,  $p < 0.001$ ), revealed that correlations between items were sufficiently large for maximum likelihood analysis. Three factors had eigenvalues larger than Kaiser's criterion of 1 in each data, and in combination, they explained 40.4% and 40.4% of the variance (T town 2005 and T town 2006, respectively). The Cronbach's alphas of all factors were over 0.7, and Cronbach's alpha for the total score was over 0.8. Confirmatory factor analysis which defined factors as latent variables and items belonging to those factors as observable variables, found the GFI to be .988, .997 and 1.00 for Factors I, II and III in 2005 and .985, 1.00 and 1.00 for Factors I, II and III in 2006, respectively. Table 3 summarizes the items reproduced in consecutive years. Factor I comprised seven items: “prefers to stay at home”; “feels full of energy (reversed)”; “is afraid that something bad will happen”; “believes that most people are better off”; “has dropped activities or interests”; “often feels helpless”; “has problems with memory.” Factor II comprised four items: “satisfied with life (reversed)”; “in good spirits (reversed)”; “happy most of the time (reversed)”; and “feels wonderful to be alive now (reversed).” Factor III comprised three items: “life feels empty,” “often gets bored,” and “feels present self is worthless.” The item “situation is hopeless” was loaded differently in the consecutive years.

Table 4 shows the correlation between factors and variables for consecutive years. The correlation between factors and socio-demographic variables, and between past and present illness were

**Table 2**  
Factor analysis of 15-item Geriatric Depression Scale in T town between 2005 and 2006.

Item	2005			2006			
	I	II	III	I	II	III	
1	Satisfied with life (reversed)	0.31	<b>0.66</b>	0.22	0.30	<b>0.69</b>	0.19
2	Dropped activities, interest	<b>0.53</b>	0.17	0.18	<b>0.63</b>	0.18	0.19
3	Life is empty	0.36	0.28	<b>0.52</b>	0.35	0.33	<b>0.48</b>
4	Often bored	0.28	0.17	<b>0.55</b>	0.23	0.13	<b>0.58</b>
5	In good spirits (reversed)	.05	<b>0.35</b>	.25	0.04	<b>0.36</b>	.30
6	Afraid something bad will happen	<b>0.53</b>	0.24	0.21	<b>0.49</b>	0.25	0.24
7	Happy most of the time (reversed)	0.21	<b>0.39</b>	0.14	0.26	<b>0.72</b>	0.11
8	Often feel helpless	<b>0.63</b>	0.12	0.16	<b>0.64</b>	0.18	0.24
9	Prefer to stay at home	<b>0.39</b>	–0.01	0.20	<b>0.39</b>	0.07	0.24
10	Problems with memory	<b>0.43</b>	0.09	0.16	<b>0.32</b>	0.08	0.27
11	Wonderful to be alive now (reversed)	0.19	<b>0.53</b>	0.53	0.21	<b>0.55</b>	0.31
12	Feel worthless	0.30	0.25	<b>0.65</b>	0.25	0.34	<b>0.58</b>
13	Feel full of energy (reversed)	<b>0.47</b>	0.27	0.07	<b>0.47</b>	0.25	0.03
14	Situation is hopeless	<b>0.51</b>	0.28	0.39	0.41	0.33	<b>0.45</b>
15	Most people are better off than you	<b>0.42</b>	0.27	0.15	<b>0.39</b>	0.34	0.24
Eigenvalues		2.4	1.9	1.7	2.3	2.1	1.7
Proportion of variance explained		16.3	12.5	11.6	15.2	14.0	11.2
Cronbach's alpha (factors)		0.78	0.75	0.74	0.75	0.76	0.76
Cronbach's alpha (total)		0.87			0.87		

Method of factor extraction: maximum likelihood solution.  
Rotation method: varimax rotation.  
Values in italics and boldface indicate the items composing the factor.

**Table 3**  
Summary of the reproduced factors of the 15-item Geriatric Depression Scale in Tosa for 2 consecutive years.

Factor	Tosa
I	Prefer to stay at home
	Feel full of energy (reversed)
	Afraid something bad will happen
	Most people are better off than you
	Dropped activities, interest
II	Often feel helpless
	Problems with memory
	Satisfied with life (reversed)
	In good spirits (reversed)
	Happy most of the time (reversed)
III	Wonderful to be alive now (reversed)
	Your life is empty
	Often get bored
Unstable	Feel pretty worthless
	Situation is hopeless

Factor names correspond to those in Table 2.

weak. Almost all factors correlated significantly and moderately with QOL; however, the correlations between factor II and relationships with family and friends were weak.

#### 4. Discussion

There have been four studies on the factors of the Japanese version of the GDS-15 (Onishi et al., 2006, 2004; Yatomi, 1994; Schreiner et al., 2001). However, results have been inconsistent, with the number of reported factors ranging from two to four. Further, while some of these studies evaluated the association between these factors and functional disability, none of them evaluated the reproducibility of the factors. Other studies on the factor structure of the GDS-15 conducted outside Japan did not investigate its reproducibility, although some studies did perform confirmatory factor analysis, which only showed goodness-of-fit. To the best of our knowledge, the present study is the first study to

demonstrate both the reproducibility of the factor structure of the GDS-15 and its relationship to QOL.

The present study, conducted over two consecutive years revealed that the Japanese version of the GDS-15 had three replicable factors. Factor I could be defined as “energy loss and pessimistic outlook,” factor II as “positive mental status (reversed),” and factor III as “empty feeling.” These factors had acceptable internal consistency, as evidenced by their high Cronbach's alphas, and confirmatory factor analysis confirmed that these factors had good fit with the model with GFIs over 0.9.

A comparison between the present study and a meta-analysis reveals a number of commonalities. The positive items “satisfaction with life,” “good spirits,” “happy most of the time,” and “wonderful to be alive now” belong to the same factor in both English and Korean versions of the GDS-15, as well as in the Japanese version, found in the present study (Kim et al., 2012). However, “satisfaction with life” and “happy most of the time” are the only items from this group found in the same factor in the Chinese version (Kim et al., 2012). These results suggest two things. The first thing is that “satisfaction with life” and “happy most of the time” may represent universal aspects of this component; since “good spirits” and “wonderful to be alive now” are found in both in English and Korean versions as well as in the Japanese version, found in the present study – three languages and cultures that differ greatly – these items are generally included in the positive factor and could be universal, which should be determined in the future study. Second, the item “feel full of energy” appears at first glance to belong to the positive factor; however, this item may have a fundamentally different nature than the other positive items, as this item is included only in the Korean version.

Another commonality is that “dropped activities” and “prefer to stay at home” belong to the same factor in the English, Chinese and Japanese versions of the GDS-15. It is logical that these two items would go together, as staying home more is likely to entail dropping activities. However, the other items belonging to this factor differ according to version. “Memory problems” is included in both the English and Chinese versions, but not in the Japanese version, and “afraid that something will happen” is included in

**Table 4**  
Correlation between factors of GDS-15, socio-demographic variables, ADLs, medical history and QOLs in Tosa (town) for consecutive years.

	2005			2006		
	I	II	III	I	II	III
Age	0.052	0.22 <sup>***</sup>	0.26 <sup>***</sup>	0.045	0.19 <sup>***</sup>	0.22 <sup>***</sup>
Loss of partner	0.036	−0.011	−0.031	0.067	0.10 <sup>***</sup>	0.078 <sup>**</sup>
Living alone	0.093 <sup>***</sup>	0.091 <sup>*</sup>	0.090 <sup>***</sup>	0.094 <sup>***</sup>	0.14 <sup>***</sup>	0.15 <sup>***</sup>
Basic ADL	−.25 <sup>***</sup>	−.33 <sup>***</sup>	−.33 <sup>***</sup>	−.25 <sup>***</sup>	−.35 <sup>***</sup>	−.37 <sup>***</sup>
Instrumental ADL	−0.27 <sup>***</sup>	−0.34 <sup>***</sup>	−0.28 <sup>***</sup>	−0.27 <sup>***</sup>	−0.35 <sup>***</sup>	−0.19 <sup>***</sup>
Intellectual activities	−0.30 <sup>***</sup>	−0.33 <sup>***</sup>	−0.24 <sup>***</sup>	−0.34 <sup>***</sup>	−0.37 <sup>***</sup>	−0.25 <sup>***</sup>
Social role	−0.34 <sup>***</sup>	−0.36 <sup>***</sup>	−0.31 <sup>***</sup>	−0.30 <sup>***</sup>	−0.35 <sup>***</sup>	−0.24 <sup>***</sup>
Independence in cognitive function	−0.24 <sup>***</sup>	−0.29 <sup>***</sup>	−0.32 <sup>***</sup>	−0.24 <sup>***</sup>	−0.27 <sup>***</sup>	−0.37 <sup>***</sup>
Hypertension	0.049	0.079 <sup>*</sup>	0.052	0.040	0.071 <sup>*</sup>	0.077 <sup>*</sup>
Stroke	0.16 <sup>***</sup>	0.12 <sup>***</sup>	0.15 <sup>***</sup>	0.15 <sup>***</sup>	0.20 <sup>***</sup>	0.16 <sup>***</sup>
Osteoarthritis	0.14 <sup>***</sup>	0.12 <sup>***</sup>	0.17 <sup>***</sup>	0.12 <sup>***</sup>	0.13 <sup>***</sup>	0.14 <sup>***</sup>
Subjective health	−0.40 <sup>***</sup>	−0.39 <sup>***</sup>	−0.47 <sup>***</sup>	−0.42 <sup>***</sup>	−0.37 <sup>***</sup>	−0.52 <sup>***</sup>
Family relationship	−0.34 <sup>***</sup>	−0.27 <sup>***</sup>	−0.35 <sup>***</sup>	−0.33 <sup>***</sup>	−0.25 <sup>***</sup>	−0.29 <sup>***</sup>
Friend relationship	−0.37 <sup>***</sup>	−0.32 <sup>***</sup>	−0.37 <sup>***</sup>	−0.33 <sup>***</sup>	−0.25 <sup>***</sup>	−0.29 <sup>***</sup>
Financial satisfaction	−0.43 <sup>***</sup>	−0.28 <sup>***</sup>	−0.39 <sup>***</sup>	−0.39 <sup>***</sup>	−0.33 <sup>***</sup>	−0.36 <sup>***</sup>
Subjective happiness	−0.52 <sup>***</sup>	−0.39 <sup>***</sup>	−0.47 <sup>***</sup>	−0.53 <sup>***</sup>	−0.37 <sup>***</sup>	−0.43 <sup>***</sup>

Pearson's r and Spearman's r were calculated for correlations of categorical and continuous variables, respectively. Factor names correspond to Table 2.

\*  $p < 0.05$ .  
\*\*  $p < 0.005$ .  
\*\*\*  $p < 0.001$ .

both the English and Japanese versions but not in the Chinese version. This could imply that “dropped activities” is connected to the impaired cognitive functioning in China and to emotional aspect in Japan, and to both cognitive and emotional aspect in Western countries.

Although the preceding section discussed similarities in factor components across languages and cultures, few studies have investigated the possible practical meaning and application of these factors. We therefore attempted to clarify the meanings of these factors with regard to QOL and ADLs.

The factor “energy loss and pessimistic outlook” correlated with the QOL more than other factors. Further, this factor was moderately correlated with all items of QOL, but the relation with subjective happiness was relatively higher than that with other QOL. Items composing the factor “energy loss and pessimistic outlook” should be considered when the focus of evaluation is on the QOL. Especially, as the items “prefers to stay at home,” “has dropped activities or interests,” and “has problems with memory” can be objectively observed, these questions may be useful in clinical practice or community screening.

The factor “positive mental status” also correlated with the QOL, but it seems to reflect ADLs more than the QOL. In fact, a study showed that the unimpaired positive items of the GDS-15 had a favorable effect on the maintenance of functional ability expressed as BADL (Hirosaki et al., Kasahara). Another study (Chiu et al., 1994) also indicated that positive mental status correlated with BADL yielding a correlation coefficient of  $-0.37$ . Our results support these findings, but they showed that advanced ADL such as IADL, intellectual activities, and social roles seem to be related more to this factor than to BADL. Further research is required on the predictive value of “positive mental health” against advanced ADLs. The status of ADLs may be inferred by referring items composing this factor.

Most of the correlations between the “empty feeling” factor and the variables investigated in this study were weaker than the correlation with other factors. Only the correlation with independence in subjective cognitive function was stronger for this factor than for the other factors. Interestingly, the factor containing the item “problems with memory” had a weak correlation with independence in subjective cognitive function. One possible explanation is that substantial cognitive impairment may be

expressed indirectly in Japan. It is said that depression tends to be denied or expressed somatically in China (Parker et al., 2001). This result may be applied to the expression of cognitive function in Japan. As impaired subjective cognitive function could be expressed as an “empty feeling,” we should be mindful of memory function if complaints about an “empty feeling” are observed and vice versa.

This study is limited in that objective functional variables were not included. However, previous research involving patients with parkinsonism revealed that the patients accurately self-reported their disability, even in the presence of depression and cognitive impairment (Brown et al., 1989). Considering this, our results are not misdirected. Another limitation is that investigated variables showed moderate correlation with factors at the most. The present study does not fully explain the meaning of each factor; further study with more variables may be required.

We were concerned that the generalizability of our results might be limited, as T town is more rural than most of Japan; however, while much of Japan is highly urbanized, according to a national census about 45% of Japanese cities, towns and villages have depopulated areas (Bureau, 2010). Additionally, the average GDS-15 scores of community-dwelling elderly persons, as reported by Onishi et al. (2006) and Matsubayashi et al. (2010) were 5.1 (3.5) and 4.4 (3.2), comparable to our score of 4.7 (3.9). These facts support the generalizability of our results at least in part.

In conclusion, our study revealed that GDS-15 consisted of 3 reproducible factors. The correlation between factors and variables were different; 1 factor showed more correlation with the QOL, another factor correlated more with the ADLs, and the last factor correlated more with the subjective cognitive function. These results suggest that the GDS-15 can be used as a tool for assessing functional ability and QOL as well as depressive mood.

#### Acknowledgments

We wish to thank all the participants and community workers of T town in Japan who aided in this study. This study was supported by Grant-in-Aid of Ministry of Health, Welfare and Labor: Choju-Kagaku Kenkyu (No. 005, Leader: Kenji Toba), Grant-in-Aid of Research

Institute for Humanity and Nature (3–4 FR). Authors declare no conflict of interest.

## References

- American Psychiatric Association, 2000. *Diagnostic and statistical manual of mental disorders*. 4th Ed., Text Review, Washington, DC.
- Brown, P.J., Woods, C.M., Storandt, M., 2007. Model stability of the 15-item Geriatric Depression Scale across cognitive impairment and severe depression. *Psychology and Aging* 22, 372–379.
- Brown, R.G., MacCarthy, B., Jahanshahi, M., Marsden, C.D., 1989. Accuracy of self-reported disability in patients with parkinsonism. *Archives of Neurology* 46, 955–959.
- Bureau J.S. 2010 Population Census In: *Institute D-GfPPSSaSRaT* (Ed.), Japan.
- Chiu, H.F., Lee, H.C., Wing, Y.K., Kwong, P.K., Leung, C.M., Chung, D.W., 1994. Reliability, validity and structure of the Chinese Geriatric Depression Scale in a Hong Kong context: a preliminary report. *Singapore Medical Journal* 35, 477–480.
- Cole, M.G., Dendukuri, N., 2003. Risk factors for depression among elderly community subjects: a systematic review and meta-analysis. *American Journal of Psychiatry* 160, 1147–1156.
- de Boer, A.G., van Lanschot, J.J., Stalmeier, P.F., van Sandick, J.W., Hulscher, J.B., de Haes, J.C., Sprangers, M.A., 2004. Is a single-item visual analogue scale as valid, reliable and responsive as multi-item scales in measuring quality of life? *Quality of Life Research* 13, 311–320.
- Hirosaki, M., Ishimoto, Y., Kasahara, Y., Konno, A., Kimura, Y., Fukutomi, E., Chen, W., Nakatsuka, M., Fujisawa, M., Sakamoto, R., Ishine, M., Okumiya, K., Otsuka, K., Wada, T., Matsubayashi, K., 2013. Positive affect as a predictor of lower risk of functional decline in community-dwelling elderly in Japan. *Geriatrics and Gerontology International* 13, 1051–1058.
- Incalzi, R.A., Cesari, M., Pedone, C., Carbonin, P.U., 2003. Construct validity of the 15-item geriatric depression scale in older medical inpatients. *Journal of Geriatric Psychiatry and Neurology* 16, 23–28.
- Ishizaki, T., Watanabe, S., Suzuki, T., Shibata, H., Haga, H., 2000. Predictors for functional decline among nondisabled older Japanese living in a community during a 3-year follow-up. *Journal of the American Geriatrics Society* 48, 1424–1429.
- Iwata, N., Umetsue, M., Egashira, K., Hiro, H., Mizoue, T., Mishima, N., Nagata, S., 1998. Can positive affect items be used to assess depressive disorders in the Japanese population? *Psychological Medicine* 28, 153–158.
- Jang, Y., Kwag, K.H., Chiriboga, D.A., 2010. Not saying I am happy does not mean I am not: cultural influences on responses to positive affect items in the CES-D. *Journals of Gerontology Series B: Psychological Sciences* 65, 684–690.
- Japanese Ministry of Health LaW, 2009. *A Text Book for Primary Nursing Care Requirement Authorization*.
- Kim, G., Decoster, J., Huang, C.H., Bryant, A.N., 2012. A meta-analysis of the factor structure of the Geriatric Depression Scale (GDS): the effects of language. *International Psychogeriatrics*, 1–11.
- Koyano, W., Shibata, H., Nakazato, K., Haga, H., Suyama, Y., 1991. Measurement of competence: reliability and validity of the TMIG index of competence. *Archives of Gerontology and Geriatrics* 13, 103–116.
- Lehtinen, V., Joukamaa, M., 1994. Epidemiology of depression: prevalence, risk factors and treatment situation. *Acta Psychiatrica Scandinavica Supplementum* 377, 7–10.
- Matsubayashi, K., Wada, T., Okumiya, K., Fujisawa, M., Taoka, H., Kimura, S., Doi, Y., 1994. Comparative study of quality of life in the elderly between in Kahoku and in Yaku. *Nihon Ronen Igakkai Zasshi* 31, 790–799.
- Matsubayashi, K., Okumiya, K., Wada, T., Osaki, Y., Doi, Y., Ozawa, T., 1996. Secular improvement in self-care independence of old people living in community in Kahoku. *Japan Lancet* 347, 60.
- Matsubayashi, K., Okumiya, K., Osaki, Y., Fujisawa, M., Doi, Y., 1997. Quality of life of old people living in the community. *Lancet* 350 (9090), 1521–1522.
- Matsubayashi, K., Sakagami, T., Wada, T., Ishine, M., Sakamoto, R., Yamanaka, G., Otsuka, K., Fujisawa, M., Okumiya, K., 2010. Mood disorders in community-dwelling older adults in Asia. *Journal of the American Geriatrics Society* 58, 213–214.
- Morrison, D.P., 1983. The crichton visual analogue scale for the assessment of behaviour in the elderly. *Acta Psychiatrica Scandinavica* 68, 408–413.
- Niino, N., Imaizumi, T., Kawakai, N.A., 1991. Japanese translation of the Geriatric Depression Scale. *Clinical Gerontologist* 10, 85–86.
- Nyunt, M.S., Fones, C., Niti, M., Ng, T.P., 2009. Criterion-based validity and reliability of the Geriatric Depression Screening Scale (GDS-15) in a large validation sample of community-living Asian older adults. *Aging and Mental Health* 13, 376–382.
- Onishi, J., Umegaki, H., Suzuki, Y., Uemura, K., Kuzuya, M., Iguchi, A., 2004. The relationship between functional disability and depressive mood in Japanese older adult inpatients. *Journal of Geriatric Psychiatry and Neurology* 17, 93–98.
- Onishi, J., Suzuki, Y., Umegaki, H., Endo, H., Kawamura, T., Iguchi, A., 2006. A comparison of depressive mood of older adults in a community, nursing homes, and a geriatric hospital: factor analysis of Geriatric Depression Scale. *Journal of Geriatric Psychiatry and Neurology* 19, 26–31.
- Parker, G., Gladstone, G., Chee, K.T., 2001. Depression in the planet's largest ethnic group: the Chinese. *American Journal of Psychiatry* 158, 857–864.
- Salamero, M., Marcos, T., 1992. Factor study of the Geriatric Depression Scale. *Acta Psychiatrica Scandinavica* 86, 283–286.
- Schreiner, A.S., Morimoto, T., Asano, H., 2001. Depressive symptoms among poststroke patients in Japan: frequency distribution and factor structure of the GDS. *International Journal of Geriatric Psychiatry* 16, 941–949.
- Schreiner, A.S., Hayakawa, H., Morimoto, T., Kakuma, T., 2003. Screening for late life depression: cut-off scores for the Geriatric Depression Scale and the Cornell Scale for Depression in Dementia among Japanese subjects. *International Journal of Geriatric Psychiatry* 18, 498–505.
- Sheikh, J.I., Yesavage, J.A., 1986. *Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version*. Haworth Press, New York.
- Yatomi, N., 1994. The factor structure and item characteristics of the GDS (Geriatric Depression Scale) short version in a Japanese elderly sample. *Ronen Shakai Kagaku* 16, 29–36. (Article in Japanese).
- Yesavage, J.A., Brink, T.L., Rose, T.L., Lum, O., Huang, V., Adey, M., Leirer, V.O., 1982. Development and validation of a geriatric depression screening scale: a preliminary report. *Journal of Psychiatric Research* 17, 37–49.

**COMPREHENSIVE GERIATRIC ASSESSMENT REVEALS SLEEP DISTURBANCES IN COMMUNITY-DWELLING ELDERLY ADULTS ASSOCIATED WITH EVEN SLIGHT COGNITIVE DECLINE**

*To the Editor:* Advancing age is commonly associated with greater likelihood of sleep disturbances and cognitive impairment. Many studies<sup>1-4</sup> show strong associations between sleep quality and cognition in older adults with dementia and with mild cognitive impairment. Few studies examined sleep quality in older community-dwelling people with only slightly impaired cognition (Mini-Mental State Examination (MMSE) score  $\geq 25$ ). Sleep disturbances in older adults may be less a function of age per se and more a function of other factors accompanying aging.<sup>5</sup> A community-based geriatric assessment of elderly adults<sup>6</sup> was performed to investigate whether there were significant associations between mild cognitive decline and poor sleep quality indicators in older citizens in a rural Japanese town.

The study population consisted of 691 individuals aged 75 to 102 (male:female 237:454, mean age  $81.0 \pm 4.6$ ) living in a rural Japanese town (Tosa, Kochi prefecture). Participants had scores of 25 or above on the MMSE (range 0-30). They were classified into three classes according to MMSE score (29-30,  $n = 282$ , aged  $80.5 \pm 4.2$ ; 27-28,  $n = 219$ , aged  $81.5 \pm 4.6$ ; 25-26,  $n = 190$ , aged  $81.0 \pm 4.9$ ; Table 1). Hasegawa Dementia Rating Scale-Revised (range 0-30) were  $28.5 \pm 2.0$ ,  $27.1 \pm 2.2$  and  $26.2 \pm 2.5$ , respectively, for each MMSE group, and Frontal Assessment Battery (range 0-18) scores were  $13.5 \pm 2.4$ ,  $12.5 \pm 2.7$  and  $11.7 \pm 2.4$  for each MMSE group, respectively. Scores were lower with lower MMSE score.

A self-reported questionnaire assessed sleep characteristics. Average total sleep time was  $7.99 \pm 1.22$  hours, time of getting-up was  $5:59 \pm 0:47$ , and time of going to bed was  $21:58 \pm 1:07$ . Feeling of poor-quality sleep (18.3%), use of sleep medication (28.7%), nocturnal waking for urination (79.4%;  $\geq 2$  times 16.3%), trouble falling asleep after nocturnal waking (36.3%), waking too early (29.2%), and waking not rested (44.6%) were reported.

Sleep complaints (feeling of poor-quality sleep, use of sleep medication, difficulty maintaining sleep, waking too early, waking not rested, daytime napping) were not statistically significantly associated with cognition. Elderly adults with lower MMSE scores slept longer (7.86, 7.97, and 8.22 hours, respectively;  $P = .008$ ) and had more-frequent episodes of nocturia (1.65, 1.83, and 2.01 times, respectively;  $P = .006$ ), in keeping with results from previous studies.<sup>5,7</sup>

The incidence of restless legs syndrome, sleep paralysis, sleep talking, and teeth-grinding were not statistically significantly different between the three MMSE groups, but fewer subjects with lower MMSE scores reported leg cramps (39.9%, 34.7%, and 30.4%, respectively;  $P = .03$ ) and snoring (38.2%, 40.4%, and 29.6%, respectively;  $P = .06$ ).

Several clinical signs were reported during sleep: waking from dry mouth (12.9%), nocturnal palpitation (2.2%), vague chest anginal discomfort (1.9%), and heartburn (5.1%). Only awakening from vague chest discomfort was less frequent in participants with higher MMSE scores (0.4%, 3.2%, and 2.7%, respectively;  $P = .04$ ).

Previous studies showed an association between depressive mood and subjective quality of life (QOL),<sup>6,8</sup> but in this investigation, there were no differences in

**Table 1. Associations Between Mini-Mental State Examination (MMSE) and Subjective Sleep Symptoms, Depression, Quality of Life (QOL), Physical Function, and Cardiovascular Function in Elderly Adults in a Rural Japanese Town**

Characteristic	Total, N = 691	MMSE 29-30, n = 282	MMSE 27-28, n = 219	MMSE 25-26, n = 190	P-Value
Age, mean $\pm$ SD	81.0 $\pm$ 4.6	80.5 $\pm$ 4.2	81.5 $\pm$ 4.6	81.0 $\pm$ 4.9	.08
Female, %	65.7	68.4	65.3	62.1	.36
Body mass index, kg/m <sup>2</sup> , mean $\pm$ SD	22.9 $\pm$ 3.5	23.1 $\pm$ 3.5	22.5 $\pm$ 3.4	23.0 $\pm$ 3.4	.36
MMSE score, mean $\pm$ SD	27.8 $\pm$ 1.7	29.5 $\pm$ 0.5	27.5 $\pm$ 0.5 <sup>a</sup>	25.5 $\pm$ 0.5 <sup>b,c</sup>	<.001
Hasegawa Dementia Rating Scale—Revised, mean $\pm$ SD	27.5 $\pm$ 2.4	28.5 $\pm$ 2.0	27.1 $\pm$ 2.2 <sup>a</sup>	26.2 $\pm$ 2.5 <sup>b,c</sup>	<.001
Frontal Assessment Battery, mean $\pm$ SD	12.7 $\pm$ 2.6	13.5 $\pm$ 2.4	12.5 $\pm$ 2.7 <sup>a</sup>	11.7 $\pm$ 2.4 <sup>b,c</sup>	<.001
Sleep duration, hours, mean $\pm$ SD	7.99 $\pm$ 1.22	7.86 $\pm$ 1.14	7.97 $\pm$ 1.28 <sup>a</sup>	8.22 $\pm$ 1.24 <sup>b,c</sup>	.008
Feeling of poor sleep quality, %	18.3	15.1	22.6	18.0	.11
Medicine for sleep, %	28.7	30.9	26.4	28.1	.54
Nocturnal waking, %	20.6	75.8	82.5	81.2	.15
Number of nocturia episodes per night, mean $\pm$ SD	1.81 $\pm$ 0.93	1.65 $\pm$ 0.83	1.83 $\pm$ 0.87 <sup>a</sup>	2.00 $\pm$ 1.07 <sup>b</sup>	.006
Trouble falling asleep after nocturnal waking, %	36.3	33.7	40.2	35.5	.33
Waking too early, %	29.2	29.6	30.5	27.0	.73
Waking not rested, %	44.6	43.4	42.6	48.3	.50
Restless legs, %	20.3	18.5	23.4	19.4	.38
Leg cramps, %	35.7	39.9	34.7	30.4 <sup>a</sup>	.03
Increased dream, %	18.4	16.3	17.0	23.0	.15

(Continued)



Table 1 (Contd.)

Characteristic	Total, N = 691	MMSE 29-30, n = 282	MMSE 27-28, n = 219	MMSE 25-26, n = 190	P- Value
Sleep paralysis, %	5.9	4.7	5.5	8.2	.29
Sleep talking, %	14.3	13.5	14.4	15.7	.80
Teeth-grinding	4.3	4.0	6.0	2.7	.25
Snoring, %	36.5	38.2	40.4	29.6 <sup>f</sup>	.06
Waking from dry mouth, %	12.9	10.9	16.5	11.8	.16
Waking from hunger, %	2.2	1.5	3.2	2.1	.42
Waking from shortness of breath, %	3.5	2.5	4.6	3.7	.45
Waking from asthma-like episode, %	2.6	2.5	2.8	2.7	.98
Waking from palpitation, %	2.2	2.5	1.4	2.7	.59
Waking from vague chest anginal discomfort, %	1.9	0.4	3.2 <sup>d</sup>	2.7 <sup>e</sup>	.04
Nocturnal heartburn, %	5.1	3.6	5.5	6.9	.28
Waking from abdominal pain, %	2.2	2.9	2.8	0.5	.18
Waking from back pain, %	6.2	4.7	6.9	7.5	.41
Daytime napping, %	48.7	52.0	48.4	44.1	.25
Duration of daytime napping, minutes, mean ± SD	30.2 ± 34.0	30.4 ± 33.2	28.2 ± 30.6	32.4 ± 38.9	.62
Habit of daytime exercise, %	51.5	54.6	48.8	50.0	.40
Duration of exercise, minutes, mean ± SD	90.5 ± 100.6	86.4 ± 81.6	96.1 ± 113.9	92.1 ± 117.1	.56
Depressive mood, %	47.8	33.9	37.0	37.4	.68
Frequency of depression, %	15.3	12.0	12.8	13.5	.91
Subjective quality of life, mean ± SD					
Health	57.7 ± 20.2	57.8 ± 21.4	56.4 ± 19.6	59.2 ± 19.0	.75
Family relationships	79.9 ± 20.0	81.3 ± 20.2	79.8 ± 18.4	77.5 ± 21.8	.55
Relationships with friends	77.0 ± 20.1	79.6 ± 18.4	74.8 ± 22.6	75.4 ± 19.4	.26
Financial satisfaction	57.8 ± 23.5	57.0 ± 24.7	58.4 ± 23.1	58.5 ± 22.0	.90
Happiness	65.2 ± 21.8	65.1 ± 23.2	66.7 ± 21.8	63.6 ± 19.3	.75
Systolic blood pressure, mmHg, mean ± SD	137.4 ± 19.3	137.8 ± 20.0	136.6 ± 19.8	137.8 ± 17.8	.74
Diastolic blood pressure, mmHg, mean ± SD	75.1 ± 11.0	74.7 ± 11.1	75.0 ± 10.7	75.7 ± 11.1	.64
Pulse, beats/min, mean ± SD	67.4 ± 11.2	67.1 ± 11.5	67.7 ± 10.5	67.6 ± 11.7	.83
Orthostatic hypotension, %	10.6	7.5	11.0	14.7 <sup>e</sup>	.01
Orthostatic hypertension, %	9.7	7.1	10.1	13.2 <sup>e</sup>	.03
Blood oxygen saturation, mean ± SD	96.2 ± 1.5	96.2 ± 1.5	96.1 ± 1.6	96.3 ± 1.5	.48
Respiration rate, number per min, mean ± SD	18.3 ± 3.9	18.2 ± 3.8	18.1 ± 3.9	18.6 ± 4.1	.50
Frequency of electrocardiographic ST-T changes, %	30.3	24.7	26.8	20.3	.40
Electrocardiographic QRS amplitude (SV1 + RV5), mm, mean ± SD	25.7 ± 8.7	25.8 ± 8.7	25.6 ± 8.7	25.7 ± 8.7	.97
Medicine for hypertension, %	64.9	70.4	64.1	56.4 <sup>e</sup>	.01
Medicine for type 2 diabetes mellitus, %	5.8	6.6	4.3	6.4	.64
Timed Up & Go test, seconds, mean ± SD	12.6 ± 3.9	12.0 ± 4.0	13.0 ± 4.1 <sup>a</sup>	12.9 ± 3.2 <sup>b</sup>	.004
Handgrip power, kg, mean ± SD	22.3 ± 7.5	22.8 ± 7.1	21.7 ± 8.0	22.2 ± 7.6	.27
Time standing on single leg, seconds, mean ± SD	24.2 ± 20.6	27.9 ± 21.2	23.5 ± 21.3 <sup>a</sup>	19.5 ± 17.4 <sup>b,c</sup>	<.001
Functional reach, cm, mean ± SD	25.9 ± 7.4	26.8 ± 7.5	25.6 ± 7.3	24.9 ± 7.1 <sup>b</sup>	.02
Button test, seconds, mean ± SD	13.9 ± 4.6	13.4 ± 4.9	14.0 ± 3.9	14.5 ± 4.9 <sup>b</sup>	.003

$P < .05$  according to Student *t*-test between <sup>a</sup>MMSE 29-30 and 27-28; <sup>b</sup>MMSE 29-30 and 25-26; <sup>c</sup>MMSE 27-28 and 25-26.

$P < .05$  according to chi-square between <sup>d</sup>MMSE 29-30 and 27-28; <sup>e</sup>MMSE 29-30 and 25-26; <sup>f</sup>MMSE 27-28 and 25-26.

SD = standard deviation.

depressive mood and five QOL items (health, relations with family and friends, financial income, happiness) between the three MMSE groups.

Nor were differences between the three MMSE groups found in terms of blood pressure, pulse, respiration rate, blood oxygen saturation, QRS amplitude of electrocardiogram showing left ventricular mass volume, and ST-T changes suggesting myocardial ischemia. In keeping with a previous report,<sup>9</sup> blood pressure coordination (orthostatic hypotension or hypertension), along with indicators of standing behavior, deteriorated in subjects with lower MMSE scores (14.6%, 21.1%, and 27.9%, respectively;  $P < .001$ ), who were less likely to be treated for hypertension.

Physical function was also assessed. Poorer function was associated with lower MMSE score, perhaps another reason for disordered sleep. Ability to perform such tests as the Timed Up & Go ( $P = .004$ ), functional reach ( $P = .02$ ), time standing on single leg ( $P < .001$ ), and button score ( $P = .003$ ) (but not handgrip power) declined with MMSE decreasing score (from 30 to 25).

Even though decline in cognitive function was minimal in the current study, the findings suggest that changes were already occurring in sleep characteristics. Total sleep time lengthened, and increases in nocturia caused sleep disturbances. Clinical symptoms started developing, such as chest pain, orthostatic hypotension, and orthostatic hypertension. A comprehensive geriatric



assessment should be undertaken in older adults to determine any changes in cognitive function and prevent the development of insomnia-related diseases, if cognitive changes indeed precede rather than follow<sup>10</sup> decline in sleep quality.

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## ACKNOWLEDGMENTS

We would like to extend our thanks to all study participants.

**Conflict of Interest:** The editor in chief has reviewed the conflict of interest checklist provided by the authors and has determined that the authors have no financial or any other kind of personal conflicts with this paper.

**Author Contributions:** Yamanaka T: data analysis, writing of the manuscript. Oinuma, Sasaki, Yamanaka G: data collection and analysis. Cornelissen, Otsuka, Okumiya, Matsubayashi: study design.

**Sponsor's Role:** None.

## REFERENCES

1. Bequieu-Bonnequ S, Hudon C. Sleep disturbances in older adults with mild cognitive impairment. *Int Psychogeriatr* 2009;21:654–666.
2. Blackwell T, Yaffe K, Ancoli-Israel S et al. Association of sleep characteristics and cognition in older community-dwelling men: The MrOS Sleep Study. *Sleep* 2011;34:1347–1356.
3. Keage HAD, Banks S, Yang KL et al. What sleep characteristics predict cognitive decline in the elderly? *Sleep Med* 2012;13:886–892.
4. Potvin O, Lorrain D, Forget H et al. Sleep quality and 1-year incident cognitive impairment in community-dwelling old adults. *Sleep* 2012;35:491–499.
5. Vaz Fragoso CA, Gill TM. Sleep complaints in community-living older persons: A multifactorial geriatric syndrome. *J Am Geriatr Soc* 2007;55:1853–1866.
6. Ishine M, Okumiya K, Kimura Y et al. Subjective sleep disturbances were closely associated with comprehensive geriatric functions in dose-responsive manner in the community-dwelling elderly people in Japan. *J Am Geriatr Soc* 2008;56:1571–1573.
7. Bliwise DL, Foley DJ, Vitiello MV et al. Nocturia and disturbed sleep in the elderly. *Sleep Med* 2009;10:540–548.
8. Paudel ML, Taylor BC, Diem SJ et al. Association between depressive symptoms and sleep disturbances in community-dwelling older men. *J Am Geriatr Soc* 2008;56:1228–1235.
9. McHugh JE, Fan CW, Kenny RA et al. Orthostatic hypotension and subjective sleep quality in older people. *Aging Ment Health* 2012;16:958–963.
10. Blackwell T, Yaffe K, Ancoli-Israel S et al. Poor sleep is associated with impaired cognitive function in older women: The Study of Osteoporotic Fractures. *J Gerontol A Biol Sci Med Sci* 2006;61A:405–410.

## GERIATRIC INCLUSIVE ART AND RISK OF IN-HOSPITAL MORTALITY IN INPATIENTS WITH DEMENTIA: RESULTS FROM A QUASI-EXPERIMENTAL STUDY

*To the Editor:* The risk of in-hospital mortality is high in older inpatients with dementia because of multiorgan impairments due to comorbidities.<sup>1</sup> Emotional well-being may improve survival in older community-dwellers.<sup>2,3</sup> It has been reported that geriatric inclusive art (GIA), a new form of art therapy for older inpatients, reduces the length of hospital stay.<sup>4</sup> GIA uses painting to make inpatients aware of their abilities through improvement in emotional well-being. Because GIA may improve emotional well-being, and emotional well-being may reduce the risk of mortality among older community-dwellers, it was hypothesized that GIA could reduce in-hospital mortality in older inpatients with dementia. The objective of the study was to determine whether a GIA session performed in individuals with dementia hospitalized in a geriatric acute care unit could reduce in-hospital mortality.

Fifty-five individuals with dementia who participated in one GIA session and 73 paired controls with dementia, matched on age, sex, living situation (community vs nursing home), and reasons for hospitalization, hospitalized in the geriatric acute care unit of Angers University Hospital, France, were prospectively included in 2012 in this quasi-experimental study. Information was collected at admission on age, sex, body mass index (BMI, kg/m<sup>2</sup>), regular physical activity ( $\geq 1$  recreational physical activity for  $\geq 1$  hour per week for the past month or longer), comorbidity burden measured using the Cumulative Illness Rating Scale for Geriatrics (CIRS-G),<sup>5</sup> history of two or more recurrent falls during the past 6 months, dementia stage (Mini-Mental State of Examination (MMSE) score 20–25 = mild; MMSE score 10–19 = moderate; MMSE score  $< 10$  = severe),<sup>6</sup> presence of depressive symptoms defined as a 4-item Geriatric Depression Scale (GDS) score of 1 or greater,<sup>7</sup> feeling of physical or psychological weakness (being tired  $\geq 3$  days a week), and reasons for admission to a geriatric acute care unit (acute organ failures vs other). Information was obtained from the participant or from a close person living with the participant. In-hospital mortality and length of hospital stay were recorded in number of days from the administrative registry of Angers University Hospital. Participation in a GIA session was defined as painting a picture under the supervision of a moderator and a nurse. Each participant participated in one session during his or her hospital stay, with a maximum of four individuals attending a session at once. Sessions lasted 90 minutes. The Angers ethics committee approved the project. Individuals with dementia were

## REFERENCES

1. Buist NR. Purple urine bags. *Lancet* 1978;1:883–884.
2. Mumoli N, Cei M. A case of purple urine. *QJM* 2009;102:147.
3. Hadano Y, Shimizu T, Takada S et al. An update on purple urine bag syndrome. *Int J Gen Med* 2012;5:707–710.
4. Mantani N, Ochiai H, Imanishi N et al. A case-control study of purple urine bag syndrome in geriatric wards. *J Infect Chemother* 2003;9:53–57.
5. Lin CH, Huang HT, Chien CC et al. Purple urine bag syndrome in nursing homes: Ten elderly case reports and a literature review. *Clin Interv Aging* 2008;3:729–734.

## RELATIONSHIP BETWEEN DEPRESSION AND BLOOD PRESSURE IN COMMUNITY-DWELLING OLDEST-OLD ADULTS IN JAPAN

*To the Editor:* “Inverse Relationship Between Depressive Symptoms and Arterial Blood Pressure in Community-Dwelling Oldest-Old Brazilians” by Rosset and colleagues<sup>1</sup> attracted our attention because of its important point of view about community-dwelling oldest-old adults. Rosset and colleagues<sup>1</sup> showed a relationship between low blood pressure (BP) and depression and discussed measures of controlling hypertension in the very old population, but the relationship between cognitive or mental functions and BP in community-dwelling elderly adults has been controversial.<sup>2–4</sup>

According to the Canadian National Population Health Survey, major depression is a possible risk factor for new-onset high BP.<sup>4</sup> On the contrary, a recent study in France indicates that people with low BP have a higher risk of developing depression, whereas those with high BP were not at greater risk for incident depression.<sup>3</sup> Moreover, another study in Norway showed that symptoms of anxiety and depression were correlated with lower BP 11 years later.<sup>5</sup> Therefore, the findings on the relationship between depression and BP in elderly adults differ across study populations, although these findings are from Western populations, and there are few reports on this relationship in Asian populations. Thus, to address this important issue, a cross-sectional study was conducted to reexamine the relationship between BP and depression in the oldest-old community-dwelling adults in Japan.

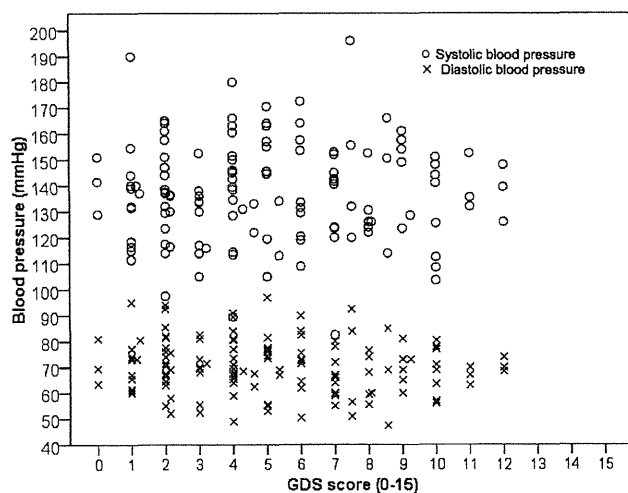


Figure 1. Relationship between blood pressure and Geriatric Depression Scale (GDS) score in community-dwelling adults aged 80 and older in Japan ( $n = 134$ , male:female = 43:91).

The total sample comprised 134 elderly people aged 80 and older living in Tosa, Japan (mean age  $\pm$  standard deviation  $84.5 \pm 3.9$ , male:female = 43:91). Data were collected in the annual health examination program that the town held in 2012. They included sociodemographic characteristics, mean systolic and diastolic BP (in two consecutive measurements with the participant in a sitting position), body mass index (BMI), Mini-Mental State Examination (MMSE) score for the assessment of cognitive functioning, 15-item Geriatric Depression Scale (GDS) score, use of antihypertensive and antidepressant medications, and subjective sense of low economic status. The ethical review board of the Graduate School of Medicine, Kyoto University, approved this study. Data were analyzed using SPSS version 20.0 (IBM Inc., Armonk, NY).

Mean number of years of education was  $8.8 \pm 2.0$ , mean MMSE score was  $26.5 \pm 3.2$ , and mean BMI was  $22.5 \pm 3.2$  kg/m<sup>2</sup>; 67.9% and 4.8% of participants used antihypertensive and antidepressant drugs, respectively. There were no significant associations between GDS score and systolic BP (correlation coefficient ( $r = 0.017$ ,  $P = .84$ ) or GDS score and diastolic BP ( $r = -0.12$ ,  $P = .17$ ) in simple (Figure 1) or quadratic regression. Moreover, these relationships remained statistically nonsignificant after controlling for age, sex, years of education, MMSE score, BMI, use of antihypertensive and antidepressant medications, and subjective low economic status.

Thus, the relationship between depression and BP that was significant in the Brazilian oldest-old population was not detected in a Japanese sample. The expression and management of depression and BP abnormality may differ depending on community, country, and social and medical situation, which may have led to the different results, although hypertension and depression in elderly adults are an important concern in Asian communities. Several reports have stated that the prevalence of hypertension in community-dwelling elderly people in Japan is greater than 70%.<sup>6,7</sup> At the same time, the prevalence of depression in elderly people in three Asian communities was reported to range from 17.2% to 33.8%.<sup>8</sup>

In conclusion, we should focus on accumulating and comparing results from samples drawn from different cultures and living environments to obtain new perspectives and insights in ethnogerontology.

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## ACKNOWLEDGMENTS

**Conflict of Interest:** The authors declare no financial or any other kind of personal conflicts with this paper.

**Author Contributions:** HI, KM, KO, TW, RS, YK: study concept, analysis of data, preparation of manuscript. MF, YI, EF, WC, MT: interpretation of data, critical review of manuscript. All authors made substantial intellectual contributions to this manuscript.

**Sponsor's Role:** None.

## REFERENCES

- Rosset I, Rodrigues RP, Rizzi L et al. Inverse relationship between depressive symptoms and arterial blood pressure in community-dwelling oldest-old Brazilians. *J Am Geriatr Soc* 2013;61:465–467.
- Okumiya K, Matsubayashi K, Wada T et al. J-curve relation between blood pressure and decline in cognitive function in older people living in community, Japan. *J Am Geriatr Soc* 1997;45:1032–1033.
- Godin O, Elbejjani M, Kaufman JS. Body mass index, blood pressure, and risk of depression in the elderly: A marginal structural model. *Am J Epidemiol* 2012;176:204–213.
- Patten SB, Williams JV, Lavorato DH et al. Major depression as a risk factor for high blood pressure: Epidemiologic evidence from a national longitudinal study. *Psychosom Med* 2009;71:273–279.
- Hildrum B, Mykletun A, Holmen J et al. Effect of anxiety and depression on blood pressure: 11-year longitudinal population study. *Br J Psychiatry* 2008;193:108–113.
- Davarian S, Crimmins E, Takahashi A et al. Sociodemographic correlates of four indices of blood pressure and hypertension among older persons in Japan. *Gerontology* 2013;15:15.
- Sekikawa A, Hayakawa T. Prevalence of hypertension, its awareness and control in adult population in Japan. *J Hum Hypertens* 2004;18:911–912.
- Wada T, Ishine M, Sakagami T et al. Depression, activities of daily living, and quality of life of community-dwelling elderly in three Asian countries: Indonesia, Vietnam, and Japan. *Arch Gerontol Geriatr* 2005;41:271–280.

## EFFECT AND SUSTAINABILITY OF PHARMACY OUTREACH SERVICES IN ELDERLY ADULTS: A 5-YEAR EXPERIENCE IN HONG KONG

*To the Editor:* The population of older adults is growing in Hong Kong. According to the Hong Kong Census and Statistics Department, in 2010, the proportion of people aged 65 and older is expected to be 28% in 2036.<sup>1</sup> Heart disease and cerebrovascular disease are, respectively, the

second and fourth leading causes of death in Hong Kong.<sup>2</sup> The Asia Pacific Cohort Study found that a 10-mmHg reduction in systolic blood pressure (SBP) was associated with a 30% reduction in deaths from cardiovascular disease and a 41% reduction in stroke.<sup>3</sup> Poor control of hypertension and diabetes mellitus were the major reasons for referrals from general outpatient clinics (GOPC) to the emergency department in Hong Kong.<sup>4</sup> Individuals with poor control of chronic diseases generally require more-personalized interventions to monitor adherence to treatment and lifestyle modifications.<sup>5</sup> Hong Kong has a largely government-based subsidized healthcare system, with more than 90% of secondary and tertiary care provided in physician consultations in the public sector; a general outpatient clinic visit lasts an average of 3 to 5 minutes.<sup>6</sup> It is difficult to provide adequate counseling and medication review during such a short visit, so the current study aimed to investigate the effect of a pharmacy outreach service (POS) in Hong Kong on hypertension and diabetic control in community-dwelling elderly adults and the sustainability of such a service.

A 5-year, multicenter, prospective service was provided from 2007 to 2012 at seven senior centers in Hong Kong. Subjects aged 60 and older with uncontrolled hypertension or diabetes mellitus were recruited. Subjects were visited every 1 to 3 months and provided with medication reviews and counseling, blood pressure (BP) and glucose monitoring, hypertension and diabetes mellitus education, and adherence reinforcement from a pharmacist and trained pharmacy students. The primary outcome was change in BP between baseline and the last visit. Secondary outcomes were changes in random capillary blood glucose (RCBG) levels, body mass index (BMI), disease knowledge scores, adherence scores, and observed drug-related problems (DRPs).

Three hundred sixty-five subjects (mean age  $77.1 \pm 7.2$ ; 69.3% female) were followed for 5 years. Statistically significant decreases were observed in SBP (from  $155.9 \pm 198.8$  to  $146.5 \pm 20.5$  mmHg;  $P < .001$ ) and diastolic BP (DBP; from  $74.6 \pm 11.3$  to  $70.1 \pm 10.2$  mmHg;  $P < .001$ ). Hypertension ( $11.7 \pm 18.3\%$ ,  $P < .001$ ) and diabetes mellitus ( $12.4 \pm 13.9\%$ ,  $P < .001$ ) knowledge scores increased significantly. Adherence improved significantly in the last 2 years ( $P < .05$ ). Five hundred ninety-nine DRPs were identified. Changes in BMI and RCBG levels were insignificant. Subjects who participated in a POS two or more times had a significant decrease in SBP ( $-12.9 \pm 22.2$ ,  $P < .001$ ) and DBP ( $-6.9 \pm 11.7$ ,  $P < .001$ ) (Table 1).

In Hong Kong, it was estimated that 51.8% of men and 54.5% of women aged 65 to 74 had uncontrolled hypertension, based on the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure guidelines.<sup>7</sup> The current study demonstrated similar positive BP control in community-dwelling elderly adults.<sup>8</sup> For subjects who participated in a POS two or more times, interventions were stopped after the first time they participated, and a subsequent rebound of SBP was found. A greater rebound in BP was detected in subjects who did not have continuous monitoring of BP by POS, although a significant decrease in BP was observed when they re-entered the program. Thus, a sustained and ongoing POS is needed to detect subjects

ORIGINAL ARTICLE: BEHAVIOURAL,  
AND SOCIAL SCIENCES

## Positive affect as a predictor of lower risk of functional decline in community-dwelling elderly in Japan

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## Introduction

The importance of positive psychological well-being for our physical health has been recognized, and an increasing number of studies have examined the association between positive affect and health.<sup>1,2</sup> Older adults with a high level of positive affect have beenfound to have a lower risk of incident functional disability,<sup>3,4</sup> frailty,<sup>5,6</sup> stroke<sup>7,8</sup> and mortality.<sup>9,10</sup>

In our rapidly aging society, the maintenance of functional ability is important for the community-dwelling elderly. However, to our knowledge, little is known about the association between positive affect and functional decline in Asian countries.

Previous studies have also shown that the effects of positive affect on mortality and morbidity were independent of negative affect.<sup>11,12</sup> Most studies measured positive (and negative) affect using the items from the Center for Epidemiologic Studies Depression Scales (CES-D). A variety of measurement methods are recommended for measuring positive affect to confirm the generality of the effect of psychological well-being on health status.<sup>13</sup> The Geriatric Depression Scale (GDS) is

- 14 Coimbra AMV, Ricci NA, Coimbra IB, Costallat LTL. Falls in the elderly of the Family Health Program. *Arch Gerontol Geriatr* 2010; 51: 317-322.
- 15 Falsarella GR, Coimbra IB, Neri AL et al. Impact of rheumatic diseases and chronic joint symptoms on quality of life in the elderly. *Arch Gerontol Geriatr* 2012; 54: 77-82.
- 16 Plan and operation of the Third National Health and Nutrition Examination Survey 1988-94. Series 1: programs and collection procedures. *Vital Health Stat* 1994; 22: 1-407.
- 17 Sheikh JJ, Yesavage JA, Gulevich G. Validation of the Geriatric Psychiatry Knowledge Test.  *Hosp Community Psychiatry* 1988; 39: 369-375.
- 18 Cicconelli RM, Ferraz MB, Santos W, Meinão J, Quaresma MR. Brazilian-Portuguese version of the SF-36. A reliable and valid quality of life outcome measure. *Rev Bras Reumatol* 1999; 39: 143-150.
- 19 Ware JE. SF-36. Health Survey, 1999. [Cited 2010 Aug 16]. Available from URL: <http://www.sf36.org/tools/sf36.shtml>
- 20 Centers for Disease Control and Prevention. Prevalence of self-reported arthritis or chronic joint symptoms among adults-United States, 2001. *MMWR Report* 2002; 51: 948-950.
- 21 Song J, Chang RW, Dunlop DD. Population impact of arthritis on disability in older adults. *Arthritis Rheum* 2006; 55: 248-255.
- 22 Haywood KL. Patient-reported outcome I: measuring what matters in musculoskeletal care. *Musculoskeletal Care* 2006; 4: 187-203.
- 23 Hewlett SA. Patients and clinicians have different perspectives on outcomes in arthritis. *J Rheumatol* 2003; 30: 877-879.
- 24 Machado GP, Barreto SM, Passos VM, Lima-Costa MF. Health and aging study: prevalence of chronic joint symptoms among the elderly in Bambuí. *Rev Assoc Med Bras* 2006; 50: 367-372.
- 25 Hannan MT. Epidemiologic perspectives on women and arthritis: an overview. *Arthritis Care Res* 1996; 9: 424-434.
- 26 Basija L, Buchbinder R, Osborne RH. Quantifying the impact of transient joint symptoms, chronic joint symptoms, and arthritis: a population-based approach. *Arthritis Rheum* 2009; 61: 1312-1321.
- 27 Anandacoomarasamy A, Franssen M, Marcha L. Obesity and the musculoskeletal system. *Curr Opin Rheumatol* 2009; 21: 71-77.
- 28 Reynolds SL, Hagedorn A, Yeom J, Saito Y, Yokoyama E, Cimmins EM. A tale of two countries-the United States and Japan: are differences in health due to differences in overweight? *J Epidemiol* 2008; 18: 280-290.
- 29 Coimbra IB, Rossi E. Degenerative joint disease. In: Freitas EV, ed. *Treaty of Geriatrics and Gerontology*. Rio de Janeiro: Guanabara-Koogan, 2006; 819-823.
- 30 Centers for Disease Control and Prevention. 2009 Arthritis Meeting the Challenge. At A Glance 2009. [Cited 2009 Dec 08]. Available from: <http://cdc.gov/nccdphp/publications/aag/arthritis>.
- 31 Niu J, Zhang YQ, Torner J et al. Is obesity a risk factor for progressive radiographic knee osteoarthritis? *Arthritis Rheum* 2009; 61: 325-335.
- 32 Araújo LF, Soares AM, Fernandes L, Serrano Junior CV. Cardiovascular events: a class effect by COX-2 inhibitors. *Arg Bras Cardiol* 2005; 85: 222-229.
- 33 Gunnington M, Webb D, Qizilbash N, Blum D, Mander A, Funk M. Risk of ischaemic cardiovascular events from selective cyclooxygenase-2 inhibitors in osteoarthritis. *Pharmacoeconomics*. *Drug Saf* 2008; 17: 601-608.
- 34 Mukesh BN, Le A, Dimitrov PN, Ahmed S, Taylor HR, McCarty CA. Development of cataract and associated risk factors: the Visual Impairment Project. *Arch Ophthalmol* 2006; 124: 79-85.
- 35 Huscher D, Thiele K, Gromnica-Ihle E, Gromnica-Ihle E, Hein G, Demary W. Dose-related patterns of glucocorticoid-induced side effects. *Ann Rheum Dis* 2009; 68: 1119-1124.
- 36 Schaumberg DA, Ridker PM, Glynn RJ, Christen WG, Dana MR, Hennekens CH. High levels of plasma C-reactive protein and future risk of age-related cataract. *Ann Epidemiol* 1999; 9: 166-171.
- 37 Hoeh KF, Hsley AP, Gunstad J. Elevated C-reactive protein is related to cognitive decline in older adults with cardiovascular disease. *J Am Geriatr Soc* 2008; 56: 1898-1903.
- 38 Morley JE, Kim MJ, Haren MT, Kevorkian R, Banks WA. Frailty and the aging male. *Aging Male* 2005; 8: 135-140.
- 39 Theis KA, Murphy L, Hootman JM, Helms CG, Yelin E. Prevalence and correlates of arthritis-attributable work limitation in the US population among persons ages 18-64: 2002 National Health Interview Survey Data. *Arthritis Rheum* 2007; 57: 355-363.
- 40 Lima Costa MF, Barreto SM, Giatti L. Health status, physical functioning, health services utilization, and expenditures on medicines among Brazilian elderly: a descriptive study using data from the National Household Survey. *Cad Saude Publica* 2003; 19: 735-743.
- 41 Ingham SL, Moody A, Abhishek A, Doherty SA, Zhang V, Doherty M. Development and validation of self-reported line drawings for assessment of knee malalignment and foot rotation: a cross-sectional comparative study. *BMC Med Res Methodol* 2010; 10: 57-62.
- 42 Machado GP, Barreto SM, Passos VM, Lima-Costa MF. Health and aging study: prevalence of chronic joint symptoms among the elderly in Bambuí. *Rev Assoc Med Bras* 2004; 50: 367-372.

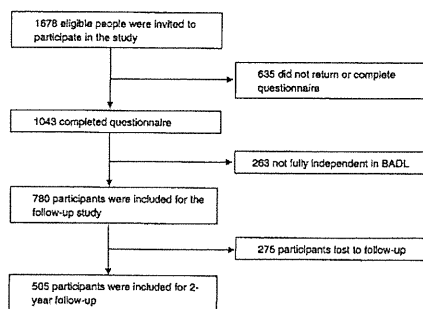


Figure 1. Flowchart of study participants.

commonly used to measure depressive symptoms in community settings, as well as the CES-D. The CES-D was designed to measure depressive symptomatology in the general population. In contrast, the GDS was specifically developed to screen and assess depression in the elderly. The present study population consisted of older adults, and it was considered appropriate to use the GDS for the assessment of the psychological status of them. The GDS includes questions about the presence of negative affect and positive affect, and does not contain somatic questions.<sup>14</sup> However, to our knowledge, there are few studies that used the positive affect items from the GDS. In the present study, we used the 15-item Geriatric Depression Scale (GDS-15)<sup>14,15</sup> for the assessment of positive affect.

Additionally, the evaluation of these individual items from the GDS was of interest, because previous studies have shown that specific items on the GDS were differently associated with age, sex and chronic illness.<sup>16,17</sup> Schultz *et al.* reported that two of the 10 individual items from the CES-D independently predicted 6-year mortality ("I felt that everything I did was an effort" and "I could not get going").<sup>18</sup> Moskowitz *et al.* also found that of the four positive items on the CES-D, the item "I enjoyed life" was significantly associated with lower risk of mortality after controlling for other confounding factors.<sup>17</sup> However, it is unclear which of the items on the GDS are more predictive of functional decline.

The aim of the present study was to test the hypothesis that the presence of positive affect would predict a lower risk of functional decline, independent of negative affect, and to examine which of the items on the GDS are more predictive of functional decline among community-dwelling older Japanese.

## Methods

### Participants

Data were collected through a community-based study, which has been carried out annually to assess the comprehensive health status of residents aged 65 years and older in Tosa Town, Kochi prefecture, Japan. The protocol was approved by the Ethical Committee of the Faculty of Medicine, Kyoto University.

In 2006, there were 1818 residents aged 65 years and older registered in Tosa Town. A self-administered questionnaire was mailed to 1678 of these residents who were not institutionalized. Of these, 1043 participants completed the questionnaires (response rate 62.2%) and 780 older adults were independent in basic activities of daily living (BADL). The follow-up study was carried out annually, and the same questionnaire that included psychological and functional status was mailed to the participants. The final study population consisted of 505 participants who completed the 2-year follow-up. Figure 1 shows the flow diagram of the present study.

Participants who completed the follow-up were older, likely to be female, less likely to drink alcohol, reported better emotional well-being and better scores of intellectual activity than non-participants (data not shown).

### Measurements

#### Psychological status

Positive affect and negative affect were assessed using the GDS-15.<sup>14,15</sup> It consists of 15 items assessing the presence of positive affect (5 items) and negative affect (10 items) in a "yes/no" format. The scale is widely used

to screen for depression in community settings, where the sum of the presence of negative affect and the absence of positive affect is calculated. In the present study, responses to the individual items were used, and positive affect summary scores and negative affect summary scores were created.

#### Functional status

To evaluate functional status, each participant rated his or her independence in seven items: (i) walking; (ii) ascending and descending stairs; (iii) feeding; (iv) dressing; (v) using the toilet; (vi) bathing; (vii) and grooming. Each BADL item was rated using the following scores: 3, completely independent; 2, requires some help; 1, requires much help; 0, completely dependent. Each item score was summed up to generate the total BADL score ranging from 0 to 21. Those scoring 21 were considered to be functionally independent in BADL.<sup>19</sup> The variable was dichotomized; those who were functionally independent were compared with those who had one or more functional impairment (those who were assigned a value of 0–20) for the analysis.

#### Covariates

Baseline sociodemographic variables included age, sex, marital status and living conditions. Smoking habits and alcohol consumption were also assessed.

Higher-level functional capacity was assessed using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) rating scale of 0–13.<sup>20</sup> The TMIG-IC scale includes scores for instrumental self-maintenance, which is equivalent to instrumental activities of daily living (0–5), intellectual activity (0–4) and social role (0–4).

Assessment of medical conditions involved self-reported medication use, and the past medical history of stroke, fracture, osteoarthritis, ischemic heart disease and cancer.

#### Statistical analysis

Data were analyzed using the SPSS statistical software package, version 15.0 for Windows (SPSS, Chicago, IL, USA). The Student's *t*-test was used for continuous variables and the  $\chi^2$ -test was used for categorical variables. Logistic regression analysis estimated the unadjusted odds ratio of functional decline at the 2-year follow-up interview for non-disabled participants at baseline. A multiple logistic regression analysis with adjustment for other confounding variables was carried out to estimate the odds of functional decline over 2 years from positive and negative affect at baseline, using the individual items from the GDS-15, as well as positive and negative affect summary scores. All of the variables that were significantly associated with func-

tional decline in the univariate analyses were considered for inclusion as potential confounding variables. A *P*-value of less than 0.05 was considered statistically significant.

## Results

Baseline characteristics of participants are provided in Table 1. The average participant age was 73.4 years, and 54.5% were female. Of the 505 participants without disability in BADL at baseline, 72 (14.3%) reported a decline in BADL at the 2-year follow-up. Participants who reported functional decline at the 2-year follow-up were older, less likely to have a spouse, and reported worse emotional well-being and worse higher-level functional capacity at baseline. They also had a higher prevalence of a history of osteoarthritis and ischemic heart disease.

Results from a univariate analysis are shown in Table 2. The sum-score of positive items (Positive-5) and four individual positive items (feeling satisfied with life, feeling happy most of the time, thinking that it is wonderful to be alive now, and feeling full of energy) were significantly associated with lower risk of functional decline. The sum-score of negative items (Negative-10) and seven individual negative items significantly predicted functional decline.

The results of a multivariate analysis are shown in Table 3. In model 1, age, having a living spouse, and history of osteoarthritis and ischemic heart disease were included as potential confounding factors. In model 2, higher-level functional capacity was added. Positive-5 (OR 0.78, 95% CI 0.64–0.97) and three positive items (feeling satisfied with life OR 0.49, 95% CI 0.25–0.98; feeling happy most of the time OR 0.50, 95% CI 0.25–0.99; and feeling full of energy OR 0.46, 95% CI 0.22–0.95) still significantly predicted a lower risk of functional decline when adjusting for potential confounding factors. In contrast, no negative items predicted functional decline after adjusting for potential confounders including higher-level functional capacity.

Positive-5 was still significantly associated with lower risk of functional decline (OR 0.66, 95% CI 0.50–0.89) after adding negative affect as confounders (Table 4), even though Positive-5 and Negative-10 were significantly correlated ( $r = -0.6$ ,  $P < 0.001$ ). Similarly, three positive items (feeling satisfied with life OR 0.36, 95% CI 0.15–0.84; feeling happy most of the time OR 0.43, 95% CI 0.19–0.94; and feeling full of energy OR 0.43, 95% CI 0.20–0.93) were significantly associated with lower risk of functional decline, independent of negative affect.

## Discussion

The results of the present study showed that the presence of positive affect predicted a lower risk of

Table 1 Baseline characteristics of participants by functional status at follow up

	Total (n = 505)	Basic ADL at 2-year follow up Independence (n = 433)	Decline (n = 72)	P-value <sup>†</sup>
Age, years (mean ± SD)	73.4 ± 6.2	72.8 ± 5.9	77.0 ± 6.6	<0.001
Female (%)	54.5	53.1	62.5	0.176
Lifestyle (%)				
Spouse alive	75.7	77.7	63.6	0.021
Living alone	15.5	14.4	22.1	0.150
Current smoker	12.1	11.9	12.9	0.983
Current alcohol drinker	40.5	41.4	35.2	0.394
GDS-15 score (mean ± SD)	4.0 ± 3.7	3.7 ± 3.6	5.6 ± 4.3	<0.001
Positive-5 score (mean ± SD)	3.7 ± 1.4	3.8 ± 1.3	3.1 ± 1.7	<0.001
Negative-10 score (mean ± SD)	2.6 ± 2.6	2.5 ± 2.5	3.7 ± 2.9	0.001
Higher-level functional capacity (mean ± SD)				
Self-maintenance	4.8 ± 0.6	4.9 ± 0.4	4.3 ± 1.3	0.001*
Intellectual activity	3.4 ± 0.9	3.5 ± 0.8	3.1 ± 1.1	0.010*
Social role	3.5 ± 0.9	3.5 ± 0.8	3.0 ± 1.1	<0.001*
Current medical conditions (%)				
Taking antihypertensive drugs	47.2	47.1	47.8	1.000
Taking antidiabetic drugs	7.2	6.7	10.3	0.418
Taking antihyperlipidemic drugs	16.2	16.5	14.1	0.734
Past medical history (%)				
Stroke	6.2	5.8	8.5	0.547
Bone fracture	17.5	17.5	17.4	1.000
Osteoarthritis	31.3	28.7	47.8	0.003
Ischemic heart disease	8.0	6.8	15.2	0.039
Cancer	7.7	8.3	4.5	0.408

<sup>†</sup>P-values were calculated using a Student's *t*-test for continuous variables and a  $\chi^2$ -test for categorical variables. \*P-values after adjusting for age, ADL, activities of daily living, GDS, Geriatric Depression Scale, SD, standard deviation.

functional decline among community-dwelling elderly in Japan, even after adjusting for other possible confounding factors. This effect was also independent of negative affect.

These findings are consistent with previous studies that have found the protective effect of positive affect on disability among elderly people in Western countries.<sup>4,7</sup> Although it has been reported that the influences of positive affect on attitudes and behaviors differ by culture in a student sample,<sup>22</sup> the effect on health might be similar in an older sample. Additionally, in most previous studies,<sup>4,44-47,14</sup> positive affect was measured using the CES-D, which included four positive items: self-esteem, feeling hopeful, feeling happy and enjoying life. In the current study, the GDS-15 was used to measure positive affect. The association between positive affect and physical functional decline was observed regardless of how positive affect was assessed, suggesting generalizability of the effect.

Negative affect was also associated with functional decline after controlling for age, marital status and past medical history. However, it was not related to functional decline after controlling for potential confound-

ing factors including higher-level functional capacity. This suggests that negative affect might be more likely to be influenced by higher-level functional capacity than positive affect.

Blazer and Hybels reported that the negative affect scale of the CES-D was not associated with mortality in older adults.<sup>13</sup> Experimental studies, in which participants are exposed to rhinovirus or influenza virus, have also shown that those who tend to feel positive emotion, such as vigor and well-being, had a lower susceptibility to developing a common cold, and had a reduced risk of developing upper respiratory illness; however, negative emotional style (such as depression, anger and hostility) was not associated with the risk of illness.<sup>24,25</sup>

Although it has been reported that depression is an independent predictor of functional decline in elderly people,<sup>24</sup> the impact of depression on functional decline might result from the absence of positive affect, rather than the presence of negative affect. It is also suggested that the relationship between negative affect and functional decline might be mediated by other factors included in the present study, such as higher-level functional capacity.

## Positive affect and functional decline

Table 2 Univariate analysis predicting functional decline at follow up

	Odds ratio	95% confidence interval	P-value
Positive-5			
Are you basically satisfied with your life? (yes vs no)	0.74	0.63-0.86	<0.001
Are you in good spirits most of the time?	0.44	0.26-0.76	0.003
Do you feel happy most of the time?	0.83	0.40-1.72	0.611
Do you think it is wonderful to be alive now?	0.46	0.27-0.79	0.005
Do you feel full of energy?	0.47	0.27-0.83	0.009
Negative-10			
Are you afraid that something bad is going to happen to you?	0.36	0.20-0.64	0.001
Have you dropped many of your activities and interests? (yes vs no)	1.18	1.08-1.29	<0.001
Do you feel that your life is empty?	2.09	1.26-3.45	0.004
Do you often get bored?	1.74	0.92-3.27	0.088
Are you often feel helpless?	2.36	1.18-4.69	0.015
Do you prefer to stay at home, rather than going out and doing new things?	0.97	0.58-1.61	0.893
Do you feel you have more problems with memory than most?	2.44	1.47-4.05	0.001
Do you feel that your situation is hopeless?	2.66	1.60-4.43	<0.001
Do you feel pretty worthless the way you are now?	1.81	1.05-3.14	0.033
Do you think that your situation is hopeless?	2.31	1.19-4.49	0.014
Do you feel that most people are better off than you are?	1.94	1.15-3.27	0.013
Age	1.46	0.88-2.44	0.143
Sex (female)	1.11	1.07-1.16	<0.001
Lifestyle	1.47	0.88-2.46	0.140
Spouse alive	0.50	0.29-0.87	0.015
Living alone	1.68	0.89-3.18	0.108
Current smoker	1.09	0.51-2.33	0.826
Current alcohol drinker	0.77	0.46-1.30	0.326
Higher-level functional capacity			
Self-maintenance (full marks)	0.18	0.10-0.34	<0.001
Intellectual activity (full marks)	0.56	0.34-0.94	0.027
Social role (full marks)	0.36	0.22-0.60	<0.001
Current medical conditions			
Taking antihypertensive drugs	1.03	0.62-1.71	0.909
Taking antidiabetic drugs	1.60	0.67-3.82	0.291
Taking antihyperlipidemic drugs	0.83	0.41-1.70	0.608
Past medical history			
Stroke	1.51	0.59-3.83	0.388
Bone fracture	0.99	0.51-1.95	0.988
Osteoarthritis	2.27	1.34-3.83	0.002
Ischemic heart disease	2.43	1.12-5.27	0.025
Cancer	0.52	0.16-1.75	0.291

It is possible that positive affect and negative affect are differently associated with physical health. Previous research has shown that the biological correlates of well-being and ill-being differ.<sup>27</sup> Future studies are required to elucidate the mechanism of how positive and negative affect is linked to health, and to explore the unique functions of positive affect.

Several possible processes that might mediate the effects of positive affect on health have been suggested.<sup>24</sup> Positive affect might influence functional decline through a psychological pathway that has a direct

effect on neuroendocrine, autonomic or immune systems. Another possibility is an indirect pathway through behavioral or psychosocial factors. For example, it has been suggested that positive affect is associated with social relationships, which are an important factor in the maintenance of functional independence.<sup>28</sup> Interestingly, the association between positive affect and functional decline was independent of social role in the present study.

The present study examined the association between functional decline and individual items on the GDS. Of



Table 3 Multivariate analysis predicting functional decline from positive and negative items, controlling for potential confounders

	Model 1			Model 2		
	OR	95% CI	P-value	OR	95% CI	P-value
Positive-5	0.71	0.59-0.86	<0.001	0.78	0.64-0.97	0.023
Basically satisfied with life	0.39	0.21-0.72	0.003	0.49	0.25-0.95	0.035
In good spirits most of the time	0.81	0.34-1.93	0.640	1.13	0.45-2.81	0.800
Feel happy most of the time	0.36	0.19-0.68	0.002	0.50	0.25-0.99	0.044
Think it is wonderful to be alive	0.45	0.23-0.87	0.017	0.58	0.28-1.18	0.133
Feel full of energy	0.34	0.18-0.68	0.002	0.46	0.22-0.95	0.036
Negative-10	1.13	1.01-1.25	0.029	1.02	0.90-1.15	0.781
Dropped activities and interests	1.71	0.96-3.06	0.070	1.23	0.64-2.35	0.540
Feel that life is empty	1.34	0.62-2.91	0.460	0.80	0.34-1.90	0.619
Often get bored	1.48	0.62-3.56	0.380	0.84	0.32-2.19	0.716
Afraid of something bad	0.82	0.45-1.49	0.516	0.62	0.32-1.20	0.154
Often feel helpless	1.91	1.06-3.43	0.030	1.27	0.66-2.44	0.475
Prefer to stay at home	2.94	1.29-4.23	0.005	1.52	0.77-2.97	0.224
Problems with memory	1.54	0.82-2.91	0.182	1.12	0.55-2.27	0.755
Feel pretty worthless	1.68	0.77-3.66	0.195	1.28	0.55-2.98	0.562
Feel that situation is hopeless	1.61	0.89-2.95	0.118	1.13	0.58-2.22	0.717
Most people are better off than I am	1.32	0.73-2.41	0.360	1.01	0.53-1.93	0.974

Model 1: Controlling for age, partner status and past medical history. Model 2: Controlling for age, partner status, past medical history and higher-level functional capacity. CI, confidence interval; OR, odds ratio.

Table 4 Multivariate analysis predicting functional decline from positive affect, controlling for potential confounders

	Model 1			Model 2		
	OR	95% CI	P-value	OR	95% CI	P-value
Positive-5	0.67	0.51-0.88	0.004	0.66	0.50-0.89	0.005
Negative-10	0.96	0.82-1.12	0.599	0.86	0.73-1.03	0.098
Age	1.12	1.07-1.17	<0.001	1.10	1.04-1.16	<0.001
Spouse alive	0.77	0.40-1.47	0.432	0.64	0.32-1.28	0.208
Osteoarthritis	1.68	0.92-3.09	0.094	2.18	1.14-4.16	0.019
Ischemic heart disease	1.91	0.80-4.55	0.147	2.05	0.82-5.15	0.125
Self-maintenance (full marks)				0.29	0.12-0.67	0.004
Intellectual activity (full marks)				0.83	0.43-1.63	0.590
Social role (full marks)				0.45	0.23-0.90	0.023

Model 1: Controlling for negative affect, age, partner status and past medical history. Model 2: Controlling for negative affect, age, partner status, past medical history and higher-level functional capacity. CI, confidence interval; OR, odds ratio.

the five positive items, feeling satisfied with life, feeling happy most of the time and feeling full of energy were associated with reduced risk of functional decline. These findings are consistent with previous studies that have shown physical health benefits of life satisfaction<sup>31,32</sup> and happiness.<sup>33</sup> The current study adds the protective effect of life satisfaction, and happiness, on functional decline in an older sample. The item, feeling full of energy, is considered to reflect emotional and physical vitality. This is consistent with a previous study

that suggested that low motivation and lack of vitality were linked to functional decline and mortality in older people.<sup>33</sup>

These three items are considered indicative of individuals' subjective perception and acceptance of their current situation. They might reflect optimism or positive self-evaluation, although positive affect is a broad concept. A positive attitude toward oneself and one's current life situation might be very helpful for the elderly to adapt successfully to various age-related

changes, which are often stressful. How an elderly person feels about a situation might be more important than the situation itself. Previous research has shown that a poor social network increased the risk of dementia; however, infrequent contacts with network resources did not increase the risk of dementia if the person was satisfied with such contacts; and conversely, having frequent contact with children increased dementia incidence if this frequency was experienced as unsatisfying.<sup>34</sup>

The item, thinking that it is wonderful to be alive now, was not associated with functional decline after controlling for confounding factors including higher-level functional capacity. It is considered that the item might be susceptible to social relationship. The item, being in good spirits most of the time, was not associated with functional decline. It might be because approximately 90% of the participants reported being in good spirits (data not shown).

The present study had some limitations. First, it is possible that the association between positive affect and functional decline is a result of some unmeasured confounding factors. Positive affect might have reflected objective health status, which was not measured in the present study. However, it has been shown that objective health measures, such as physician-based diagnosis of hypertension and diabetes mellitus, were not associated with self-rated happiness among community-dwelling elderly people.<sup>35</sup> Second, information about medical conditions was obtained from self-reports and might have been underestimated. Third, it is considered that positive or negative affect interact with higher-level functional capacity, although the causal relationship was not examined in the current study. Positive affect and especially negative affect might have reflected higher-level functional capacity, which in turn predicted functional decline. Fourth, the present study might have captured a healthier sample of the elderly population than is representative, because the participants who completed the 2-year follow up were older but reported better well-being and intellectual activity than those without follow up. Finally, positive affect was measured using the GDS-15, and there are several aspects that we have not captured. Positive affect encompasses broad concepts, such as happiness, joy, excitement, enthusiasm, activeness, pride and contentment.<sup>36</sup> Further studies are required to examine the impact of positive affect on health using a variety of measurement options for positive affect.

Greater attention in medical studies has generally been paid to the treatment of ill health and ill-being. Recently, the focus has been shifting from treatment to prevention of disease, and further, to health promotion. Much attention should also be paid to positive well-being as a part of the World Health Organization definition of health: "a state of complete physical, mental

and social well-being and not merely the absence of disease or infirmity".<sup>37</sup> However, for older people, it is more difficult to pursue perfect health than it is for the younger generation. It might be more suitable for older adults to aim toward functional, mental and social well-being regardless of disease or infirmity. Emphasis might have to be placed on leading a happier life "with aging" and not "against aging".

The results of the present study showed that the favorable effect of positive affect was independent of negative affect and of medical histories. It is possible that working toward enhancing positive affect is more important than reducing negative affect. Interventions that attempt to enhance positive affect, as well as preservation of higher-level functional capacity, might be useful for maintaining the functional independence of elderly people. It has been shown that laughter therapy, and the combination of laughter and exercise program, have positive effects on physical and mental health of older people.<sup>38,39</sup> Future interventional studies are required to confirm the protective effect of positive affect on physical health.

In conclusion, the findings suggest that the presence of positive affect, specifically the feeling of satisfaction with life, happiness and energy, plays an important role in the maintenance of functional ability among community-dwelling Japanese older people. A better understanding of the underlying mechanisms of the association between positive affect and physical health might contribute to the prevention of functional disability, and enhance quality of life.

#### Acknowledgments

We thank all of the research participants and the public health nurses in Tosa Town. This study was partly supported by a Grant-in-Aid from the JSPS Global COE Program (E-04): In Search of Sustainable Humanosphere in Asia and Africa, and a Grant-in-Aid from the Research Institute for Humanity and Nature (3-4 FR): Human Life, Aging, and Disease in High-Altitude Environments: Physio-medical, Ecological and Cultural Adaptation in Highland Civilizations.

#### Disclosure statement

All authors hereby confirm that there are no conflicts of interest.

Sponsor's role: None.

#### References

- Chida Y, Steptoe A. Positive psychological well-being and mortality: a quantitative review of prospective observational studies. *Psychosom Med* 2008; 70 (7): 741-756.

ORIGINAL ARTICLE: SOCIAL RESEARCH,  
PLANNING AND PRACTICEEthical problems in geriatrics: Views of Turkish primary  
healthcare professionalsFunda Gülay Kadioğlu,<sup>1</sup> Rana Can,<sup>2</sup> Sadık Nazik<sup>1</sup> and Selim Kadioğlu<sup>1</sup><sup>1</sup>Department of Medical Ethics, Cukurova University Faculty of Medicine, Adana and <sup>2</sup>Mustafa Kemal University Antakya Nursing School, Antakya, Turkey

**Aim:** Primary healthcare professionals frequently encounter ethical issues in the care of older adults. These issues might particularly appear in the context of "age discrimination", "respect for autonomy", "respect for privacy" and "decision-making competency". The aims of this study were to determine the frequency rates of various geriatric ethical problems and to evaluate the importance given to these problems in primary healthcare.

**Methods:** In order to evaluate the opinions, a questionnaire tool was formulated. The participants were asked to review the list of geriatric ethical issues, to state the frequency of encountering them and to identify the importance ratings for each issue. The sample consisted of 86 primary healthcare professionals (50 physicians and 36 nurses) aged between 24 and 50 years.

**Results:** Based on the results, the most frequently encountered ethical issues were on "decision-making competency" and these issues respectively were "decision-making with relatives instead of elder patients", "not informing elders due to the lack of tolerance" and "not informing elders due to the lack of comprehending". The most important geriatric ethical issues were "ignoring respect for privacy", "ignoring patient's complaints" and "rejecting detailed examination or treatment because of age".

**Conclusion:** Overall, the results show that the nurses and physicians in primary healthcare frequently encounter geriatric ethical problems related to the decision-making process, which is a common issue for Turkey as a paternalistic society. The findings show that primary healthcare professionals are sensitive to geriatric ethical issues; however, this sensitivity does not prevent the emergence of these issues. *Geriatr Gerontol Int* 2013; 13: 1059-1068.

**Keywords:** age discrimination, decision making competency, ethical problems, geriatrics, primary health care professionals.

## Introduction

In recent years, a great majority of people who benefit from primary healthcare services are, with their increasing proportion in population, individuals aged 65 years and older. The World Health Organization recognizes the critical role that primary healthcare centers play in maintaining the health of older people worldwide, and the need for these centers to be adapted and accessible to older populations. As the number of older patients benefiting from primary healthcare services is high, the

literature of geriatrics encompasses many studies focusing on the primary healthcare services.<sup>1-4</sup>

The main factors causing ethical problems specific to geriatrics are generally about the issues related to determining and respecting the autonomy of elderly people,<sup>5</sup> the dilemmas in end-of-life care, the problems arising from age discrimination and elderly patients' being at the high risk of being neglected or abused.<sup>10</sup>

Various health professionals in different positions encounter several aspects of problems regarding aging, and thus have different views about this issue. Primary healthcare professionals more frequently encounter the problems related to "respect for privacy", "informing patient and obtaining consent" and "accepting or refusing treatment". However, they less frequently have problems about the issues connected to the planning of health expenses, fair distribution of medical resources, the decision of not to resuscitate, informing patients about bad prognosis or not and participating in research.<sup>11,12</sup>

- 2 Diener E, Chan MY. Happy people live longer: subjective well-being contributes to health and longevity. *Appl Psychol Health Well Being* 2011; 3 (1): 1-43.
- 3 Pressman SD, Cohen S. Does positive affect influence health? *Psychol Bull* 2005; 131 (6): 925-971.
- 4 Diaz-Ramos JA, Navarrete-Reyes AP, Avila-Funes JA. Positive affect in elderly Mexicans and its protective role against disability. *J Am Geriatr Soc* 2012; 60 (2): 384-385.
- 5 Fisher MN, Suh SA, Ostir GV, Goodwin JS. Positive affect and disability among older Mexican Americans with arthritis. *Arthritis Rheum* 2004; 51 (1): 34-39.
- 6 Ostir GV, Markides KS, Black SA, Goodwin JS. Emotional well-being predicts subsequent functional independence and survival. *J Am Geriatr Soc* 2000; 48 (5): 473-478.
- 7 Penninx BW, Guralnik JM, Bandeen-Roche K et al. The protective effect of emotional vitality on adverse health outcomes in disabled older women. *J Am Geriatr Soc* 2000; 48 (11): 1359-1366.
- 8 Ostir GV, Ottenbacher KJ, Markides KS. Onset of frailty in older adults and the protective role of positive affect. *Psychol Aging* 2004; 19 (3): 402-408.
- 9 Park-Lee E, Fredman L, Hochberg M, Faulkner K. Positive affect and incidence of frailty in elderly women caregivers and noncaregivers: results of Caregiver-Study of Osteoporotic Fractures. *J Am Geriatr Soc* 2009; 57 (9): 627-633.
- 10 Ostir GV, Markides KS, Peek MK, Goodwin JS. The association between emotional well-being and the incidence of stroke in older adults. *Psychosom Med* 2001; 63 (2): 210-215.
- 11 Blazer DG, Hybels CF. What symptoms of depression predict mortality in community-dwelling elders? *J Am Geriatr Soc* 2004; 52 (12): 2052-2056.
- 12 Moskowitz JT, Epel ES, Acree M. Positive affect uniquely predicts lower risk of mortality in people with diabetes. *Health Psychol* 2008; 27 (1 Suppl): S75-S82.
- 13 West M, Schütz B, Webers N, Wurm S. Subjective well-being and mortality revisited: differential effects of cognitive and emotional facets of well-being on mortality. *Health Psychol* 2011; 30 (6): 728-735.
- 14 Moskowitz JT. Positive affect predicts lower risk of aids mortality. *Psychosom Med* 2003; 65 (9): 620-626.
- 15 Montorio I, Izal M. The Geriatric Depression Scale: a review of its development and utility. *Int Psychogeriatr* 1996; 8 (1): 103-112.
- 16 Niino N, Imaizumi T, Kawakami N. A Japanese translation of the Geriatric Depression Scale. *Clin Gerontol* 1991; 10 (3): 85-87.
- 17 Sheikh JJ, Yesavage JA. Geriatric Depression Scale(GDS): Recent evidence and development of a shorter version. In: Brink TL, ed. *Clinical Gerontology: A Guide to Assessment and Intervention*. New York: Haworth Press, 1986: 165-173.
- 18 Brookman BFP, Nyunt SZ, Niti M et al. Differential item functioning of the Geriatric Depression Scale in an Asian population. *J Affect Disord* 2008; 108 (3): 285-290.
- 19 Scheetz LT, Martin P, Poon LW. Do centenarians have higher levels of depression? Findings from the Georgia Centenarian study. *J Am Geriatr Soc* 2012; 60 (2): 238-242.
- 20 Schulte R, Beach SR, Ives DG, Martire LM, Ariyo AA, Kopp WJ. Association between depression and mortality in older adults: the Cardiovascular Health Study. *Arch Intern Med* 2000; 160 (12): 1761-1768.
- 21 Matsubayashi K, Okumura K, Osaki Y, Fujisawa M, Doi Y. Frailty in elderly Japanese. *Lancet* 1999; 353 (9162): 1445.
- 22 Koyano W, Shibata H, Nakazato K, Haga E, Suyama Y. Measurement of competence: reliability and validity of the TRIG Index of Competence. *Arch Gerontol Geriatr* 1991; 13: 103-116.
- 23 Ashton-James CE, Maddux WW, Galinsky AD, Chartrand TL. Who I am depends on how I feel: the role of affect in the expression of culture. *Psychol Sci* 2009; 20 (3): 340-346.
- 24 Cohen S. Emotional style and susceptibility to the common cold. *Psychosom Med* 2003; 65 (4): 652-657.
- 25 Cohen S, Alper CM, Doyle WJ, Treanor JJ, Turner RB. Positive emotional style predicts resistance to illness after experimental exposure to rhinovirus or influenza A virus. *Psychosom Med* 2006; 68 (6): 809-815.
- 26 Schillerstrom JE, Royall DR, Palmer RF. Depression, disability and intermediate pathways: a review of longitudinal studies in elders. *J Geriatr Psychiatry Neurol* 2008; 21 (3): 183-197.
- 27 Ryff CD, Dienerberg Love G, Urry HL et al. Psychological well-being and ill-being: do they have distinct or mirrored biological correlates? *Psychosom Psychosom* 2006; 75 (2): 85-95.
- 28 Steptoe A, Dockray S, Wardle J. Positive affect and psychobiological processes relevant to health. *J Pers* 2009; 77 (6): 1747-1776.
- 29 Litwin H. Social network type and health status in a national sample of elderly Israelis. *Soc Sci Med* 1998; 46 (4-5): 599-609.
- 30 Unger JB, McAvay G, Bruce ML, Berkman L, Seeman T. Variation in the impact of social network characteristics on physical functioning in elderly persons: MacArthur Studies of Successful Aging. *J Gerontol B Psychol Soc Sci* 1999; 54 (5): S245-S251.
- 31 Collins AL, Glei DA, Goldman N. The role of life satisfaction and depression symptoms in all-cause mortality. *Psychol Aging* 2009; 24 (3): 696-702.
- 32 Koivumaa-Honkanen H, Honkanen R, Vuolteenaho H, Heikkilä K, Kaprio J, Koskenvuo M. Self-reported life satisfaction and 20-year mortality in healthy Finnish adults. *Am J Epidemiol* 2000; 152 (10): 983-991.
- 33 Veenhoven R. Healthy happiness: effect of happiness on physical health and the consequences for preventive health care. *J Happiness Stud* 2008; 9: 449-469.
- 34 Fratiglioni L, Wang H-X, Ericsson K, Mayran M, Winblad B. Influence of social network on occurrence of dementia: a community-based longitudinal study. *Lancet* 2000; 355 (9212): 1315-1319.
- 35 Hirotsaki M, Ishimoto Y, Kasahara Y et al. Self-rated happiness is associated with functional ability, mood, quality of life and income, but not with medical condition in community-dwelling elderly in Japan. *Geriatr Gerontol Int* 2011; 11 (4): 531-533.
- 36 Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: the PANAS scales. *J Pers Soc Psychol* 1988; 54 (6): 1063-1070.
- 37 WHO. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948, 1946.
- 38 Hirotsaki M, Ohira T, Kajitani M et al. Effects of a laughter and exercise program on physiological and psychological health among community-dwelling elderly in Japan: randomized controlled trial. *Geriatr Gerontol Int* 2012. doi: 10.1111/j.1447-0594.2012.00877.x.
- 39 Ko H-J, Youn C-H. Effects of laughter therapy on depression, cognition and sleep among the community-dwelling elderly. *Geriatr Gerontol Int* 2011; 11 (3): 267-274.

Accepted for publication 9 November 2012.

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ORIGINAL ARTICLE: EPIDEMIOLOGY,  
CLINICAL PRACTICE AND HEALTH**Evaluation of chewing ability and its relationship with activities of daily living, depression, cognitive status and food intake in the community-dwelling elderly**

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**Aim:** The aim of this study was to assess chewing ability using color-changeable chewing gum and to show the association between chewing ability and geriatric functions, as well as dietary status in the community-dwelling elderly.

**Methods:** The study population consisted of 269 community-dwelling elderly aged  $\geq 75$  living in Tosa, Japan. Assessment of chewing ability was carried out by a dentist using color-changeable chewing gum. Activities of daily living (ADL), depression and subjective quality of life (QOL) were assessed by questionnaire. Cognitive status was assessed by; Mini-Mental State Examination (MMSE), Hasegawa Dementia Scale-Revised (HDS-R) and Frontal Assessment Battery (FAB) during the check-up. Food diversity was assessed using the 11-item Food Diversity Score Kyoto (FDSK-11).

**Results:** Number of teeth was significantly related to chewing ability ( $P < 0.001$ ). The participants with low chewing ability had significantly lower ADL scores in the items of self-maintenance ( $P = 0.029$ ) and intellectual activity ( $P = 0.021$ ). There was a significant association between low chewing ability and depression ( $P < 0.001$ ). Lower cognitive functions were significantly related to low chewing ability; MMSE ( $P = 0.022$ ), HDSR ( $P = 0.017$ ) and FAB ( $P = 0.002$ ). The participants with low chewing ability had lower food variety ( $P < 0.001$ ), and less frequent intake of beans, vegetables, seaweed and nuts, than the participants with high chewing ability.

**Conclusion:** Low chewing ability evaluated by color-changeable gum was associated with lower ADL, lower cognitive functioning, depression and food insufficiency in the community-dwelling elderly. More attention should be paid to assessing chewing ability of elderly persons in community settings. *Geriatr Gerontol Int* 2013; 13: 718–725.

**Keywords:** activities of daily living, chewing ability, cognitive function, depression, dietary intake.

**Introduction**

Oral health is a very important factor in the well-being of the elderly population. Earlier research by the authors of the current study identified a relationship between greater self-rated chewing difficulty and lower ability to carry out activities of daily living (ADL), lower quanti-

tative subjective quality of life (QOL), and higher risk of depression among the community-dwelling elderly.<sup>1</sup> In addition to self-rated chewing difficulty, objective dental assessments of the elderly in community settings are required to gain further understanding of actual oral health and its relationship with other aspects of health status through comprehensive geriatric assessment (CGA) among the elderly.<sup>2</sup> However, simultaneously using both means of assessment in a community setting is difficult, as CGA is a time-consuming process that requires completion of a variety of items.

In recent years, a relatively easy method for the evaluation of masticatory performance by using color-changeable chewing gum has been introduced,<sup>3</sup> and its

Accepted for publication 11 October 2012.

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validity and reliability have been reported.<sup>4</sup> According to the latest report, use of this method has allowed researchers to carry out surveys of the elderly population in clinical settings to evaluate the associations between masticatory performance, and both anthropometric measurements and nutritional status.<sup>5</sup> Using this method to assess chewing ability in community settings might also be a relatively easy means of assessing these relationships along with CGA. The goal of the present study was to examine the relationship between chewing ability, and both comprehensive geriatric functions and dietary status in the community-dwelling elderly population by using color-changeable chewing gum.

## Methods

### *Study design*

The present study was a cross-sectional study.

### *Ethical clearance*

This study was approved by the Ethical Committee of the Faculty of Medicine, Kyoto University, Kyoto, Japan (E-514).

### *Study population*

The present study examined 269 community-dwelling elderly individuals (88 men and 181 women) aged 75 years and older (mean  $\pm$  standard deviation =  $80.6 \pm 4.7$  years) currently residing in the town of Tosa, Kochi Prefecture, Japan, who had agreed to undergo CGA and had completed the applicable portions of the assessment in 2010. As the total population of the community-dwelling elderly aged 75 years and older in Tosa is 960 (excluding those being cared for at a hospital or nursing home), and 333 had agreed to undergo CGA in 2010, the study population represented 28.0% of the eligible population. Tosa is a rural farming town in a mountainous area that is known as one of the "super-aged" towns in Japan, having an aging rate of 41.3%.

### *Oral assessment*

During the oral assessment, assessment of chewing ability was carried out by one dentist using Masticatory Performance Evaluating Gum (XYLITOL, 70 mm  $\times$  20 mm  $\times$  1 mm, 3.0 g; Lotte, Saitama, Japan), which changes color depending on chewing performance. The participants were asked to chew the gum for 1 min as they usually chew foods. Immediately after they had chewed the gum for 2 min, the dentist checked the color of the chewed gum using a color chart with five color gradations to assign the participant a score ranging from 1 to 5 (1: very poor, 2: poor, 3: moderate, 4: good, 5: very good chewing ability).

Using a questionnaire, the participants were asked to respond "yes" or "no" to the question "In the past 6 months, have you had difficulty chewing when you eat hard foods?" to assess the subjective sense of chewing difficulty.<sup>1</sup> The dentist also determined the number of teeth and the use of dentures for each participant during the oral assessment.

### *Geriatric functioning*

Using a questionnaire, the ability to carry out ADL, presence of depressive symptoms and quantitative subjective QOL were determined to assess geriatric functioning. To assess the basic ability to carry out ADL, the participants were assigned a score ranging from 0 (completely dependent) to 3 (completely independent), reflecting their ability to carry out seven tasks: (i) walking; (ii) ascending and descending stairs; (iii) feeding themselves; (iv) dressing; (v) using the toilet; (vi) bathing; and (vii) grooming. The individual ADL scores were then summed to obtain a basic ADL score ranging from 0 to 21, with lower scores indicating greater disability.<sup>6,7</sup> For advanced ADL, the participants were assessed using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) scale,<sup>8</sup> a rated scale (0–13) that evaluates instrumental self-maintenance (0–5), intellectual activity (0–4) and social roles (0–4). The presence of depressive symptoms was screened using the Japanese version of the 15-item Geriatric Depression Scale (GDS-15).<sup>9,10</sup> Quantitative QOL was assessed using a 100-mm visual analog scale (lowest QOL on the left and highest on the right) that assessed five variables: (i) subjective sense of health; (ii) relationship with family; (iii) relationship with friends; (iv) financial satisfaction; and (v) subjective happiness.<sup>11</sup>

### *Cognitive status*

Cognitive status was assessed by clinical psychotherapists and well-trained staff by using the Mini-Mental State Examination (MMSE),<sup>12</sup> Hasegawa Dementia Scale-Revised (HDS-R)<sup>13</sup> and Frontal Assessment Battery (FAB)<sup>14</sup> during the CGA.

### *Dietary status*

Food diversity was assessed as a measure of dietary quality using the 11-item Food Diversity Score Kyoto (FDSK-11),<sup>15</sup> which evaluates frequency of consumption of 11 main food groups (grain, meat, fish and shellfish, eggs, milk, beans and soybean products, potatoes, vegetables, seaweed, nuts, and fruits). After the participants had rated their frequency of consumption of each group with a score of 1 (consumption once or more per week) or 0 (consumption less than once per week), the individual scores were summed to obtain a FDSK-11

**Table 1** Baseline characteristics of the study participants

Chewing ability	<i>n</i>	Age, mean ± SD	Sex (male/female)	Use of dentures (%)
1 (Very poor)	6	83.0 ± 6.1	1/5	66.7
2 (Poor)	21	81.1 ± 3.2	5/16	81.0
3 (Moderate)	78	81.7 ± 5.1	19/59	94.9
4 (Good)	148	80.3 ± 4.4	58/90	62.8
5 (Very good)	16	78.1 ± 4.0	5/11	31.3
Total	269	80.8 ± 4.6	88/181	71.7

SD, standard deviation. Use of dentures: includes one or more partial dentures.

score ranging from 0 to 11, with a higher score indicating greater food diversity. A more precise assessment of the frequency of food intake was carried out by asking the participants the question "How often do you eat these foods in a week?", using the same 11 food groups, to which they responded by assigning a score of 4 (every day), 3 (often or 3–5 days/week), 2 (sometimes or 1–2 days/week) or 1 (hardly ever).

### Lifestyle characteristics

To obtain data regarding their lifestyle characteristics, the participants completed a questionnaire containing items regarding their education, economic status, living/eating arrangements, employment, physical activity level, alcohol consumption and smoking habits.

### Prevalence of lifestyle-related diseases

Prevalence of lifestyle-related diseases was determined by blood chemical testing and analysis of medical records. The criteria for diagnosis of hypertension were systolic blood pressure of 140 mmHg or higher and/or diastolic pressure of 90 mmHg or higher. The criteria for hypercholesterolemia were a total cholesterol level of  $\geq 220$  mg/dL and/or a low-density lipoprotein (LDL) cholesterol level of  $\geq 140$  mg/dL. The criteria for diabetes mellitus was a casual blood glucose level of  $\geq 200$  mg/dL and/or an glycated hemoglobin level of  $\geq 6.5$ . The criterion for impaired glucose tolerance was a casual blood glucose level of  $\geq 140$  mg/dL.

### Statistical analysis

Statistical analysis was carried out using SPSS version 19.0 for Windows (SPSS, Chicago, IL, USA). The Student's *t*-test was used for continuous variables and the  $\chi^2$ -test for categorical variables. A *P*-value of  $< 0.05$  was considered an indication of statistical significance.

## Results

The number of participants, mean age, sex distribution and the percentage of the participants who were wearing

dentures (including one or more partial dentures) among the five levels of chewing ability are shown in Table 1. Six participants with a mean age of  $83.0 \pm 6.1$  years were found to have very poor chewing ability (a score of 1), whereas 16 with a mean age of  $78.1 \pm 4.0$  years were found to have very good chewing ability (a score of 5).

For comparison, all the participants were assigned into one of two groups, either a group with a relatively low chewing ability; a score between 1 and 3 ( $n = 105$ ), or a group with a relatively high chewing ability; a score of 4 or 5 ( $n = 164$ ) (Table 2). The group with low chewing ability was found to have a higher mean age, a significantly greater subjective sense of chewing difficulty ( $P = 0.005$ ) and significantly fewer teeth ( $P < 0.001$ ) than the group with high chewing ability. Regarding the last variable, a very large difference in the mean number of teeth was identified among the participants according to ability to chew foods; participants with a chewing ability score of 1 had a mean of 0.4 teeth, whereas those with a score of 5 had a mean of 22.5 teeth (Fig. 1).

In terms of geriatric functioning, participants with low chewing ability obtained significantly lower scores on the TMIG-IC ( $P = 0.047$ ), including scores for engaging in self-maintenance ( $P = 0.029$ ) and intellectual activity ( $P = 0.021$ ), than those with high chewing ability, even after adjustment for age. A significant association was found between low chewing ability and the presence of depressive symptoms as assessed by the GDS-15 ( $P < 0.001$ ), as well as between low chewing ability and relatively lower cognitive functioning as assessed by the MMSE ( $P = 0.022$ ), HDSR ( $P = 0.017$ ) and FAB ( $P = 0.002$ ), even after adjustment for age. No significant association was found between chewing ability and QOL.

A direct relationship was found between food diversity as assessed by FDSK-11 score and chewing ability score (Fig. 1). The results of Tukey's honestly significant differences post-hoc test showed a significant difference in the FDSK-11 scores between participants with chewing ability scores of 1 and 3 ( $P = 0.01$ ), and between participants with scores of 2 and 5 ( $P = 0.03$ ). As shown in Table 3, comparison of frequency of intake of 11 food items by FDSK-11 score showed that

**Table 2** Comparison of oral status, geriatric functions and cognitive status between elderly with low and high chewing ability

	Chewing ability		P-value
	Low (score 1–3; n = 105)	High (score 4, 5; n = 164)	
Age, years (mean ± SD)	81.6 ± 4.9	80.1 ± 4.4	0.023
Sex (male/female)	25/80	63/101	0.053
Body mass index (mean ± SD)	22.6 ± 3.4	23.3 ± 3.2	0.087
Oral status			
No. teeth	3.7 ± 5.7	14.6 ± 10.1	<0.001
Subjective sense of chewing difficulty (%)	52.6	33.7	0.005
Geriatric functions			
ADL (mean ± SD)			
Basic ADL score (range 0–21)	20.0 ± 1.0	20.3 ± 1.6	0.137 <sup>†</sup>
TMIG-IC (range 0–13)	10.8 ± 2.3	11.4 ± 1.9	0.047 <sup>†</sup>
Self-maintenance (range 0–5)	4.3 ± 0.9	4.7 ± 0.7	0.029 <sup>†</sup>
Intellectual activity (range 0–4)	3.0 ± 1.2	3.3 ± 0.9	0.021 <sup>†</sup>
Social role (range 0–4)	3.1 ± 1.0	3.3 ± 1.0	0.067 <sup>†</sup>
Depression, mean ± SD (range 0–15)			
Geriatric Depression Scale	5.4 ± 3.3	3.9 ± 3.5	<0.001
QOL, mean ± SD (range 0–100)			
Subjective sense of health	56.5 ± 19.8	57.4 ± 19.4	0.681
Relationship with family	78.8 ± 18.2	82.2 ± 18.3	0.140
Relationship with friends	77.4 ± 17.9	76.5 ± 20.6	0.692
Financial satisfaction	55.0 ± 21.7	56.0 ± 23.1	0.883
Subjective happiness	60.5 ± 21.0	64.5 ± 21.3	0.093
Cognitive status			
MMSE, mean ± SD (range 0–30)	25.2 ± 3.8	26.2 ± 3.2	0.022 <sup>†</sup>
HDSR, mean ± SD (range 0–30)	25.3 ± 4.2	26.5 ± 3.5	0.017 <sup>†</sup>
FAB, mean ± SD (range 0–18)	11.0 ± 2.7	12.0 ± 2.6	0.002 <sup>†</sup>

P-values were calculated using the Student's *t*-test for continuous variables and the  $\chi^2$ -test for categorical variables. <sup>†</sup>After adjustment for age by ANCOVA. FAB, Frontal Assessment Battery; HDS-R, Hasegawa Dementia Scale-Revised; MMSE, Mini-Mental State Examination, SD, Standard Deviation; TMIG-IC, Tokyo Metropolitan Institute of Gerontology Index of Competence.

participants with lower chewing ability consumed a significantly lower variety of food items ( $P < 0.001$ ), and were particularly less likely to consume fewer beans, vegetables, seaweed and nuts compared with participants with high chewing ability.

Regarding lifestyle-related factors, a significantly greater percentage of participants with high chewing ability were found to be employed or engaged in farming more than once a week ( $P < 0.001$ ) and to engage in physical activity/exercise ( $P = 0.032$ ) compared with those with low chewing ability (Table 4). In contrast, no significant associations were found between chewing ability and lifestyle-related diseases.

## Discussion

To the authors' knowledge, this was the first study to use color-changeable chewing gum to evaluate chewing

ability among a sample of the community-dwelling elderly population to identify associations between chewing ability, and both geriatric functions and dietary status. The results show that elderly individuals with relatively low chewing ability tend to be older than those with relatively high chewing ability, and thus agree with many previous studies that found that chewing ability declines with age.<sup>16,17</sup> Furthermore, identification of the same relationship between low chewing ability and a smaller number of teeth and a greater subjective sense of chewing difficulty – as has been reported by previous studies – supports the reliability of these results, and thus, the utility of the study methodology. As the present study focused on the “older-elderly,” defined as those aged 75 years and older, the results convey the important message that chewing ability is associated with age even among the “very old” elderly population, and thus highlight that maintaining oral health is important across the entire lifespan.