RESEARCH ARTICLE

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Association between depressive symptoms and metabolic syndrome in Japanese community-dwelling older people: a cross-sectional analysis from the baseline results of the Fujiwara-kyo prospective cohort study

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Objective: Metabolic syndrome contains many risks for medical diseases such as cardiovascular disease and diabetes, which might precipitate depressive symptoms in the older people. However, the association between depressive symptoms and metabolic syndrome in Japanese community-dwelling older people is unclear. This study was performed to answer this important question.

Methods: Cross-sectional analyses were performed on 3796 community-dwelling independent older people (≥65 years, 1911 men and 1885 women) from the 2007–2008 baseline examination of the Fujiwara-kyo study, a prospective cohort study on successful aging. Depressive symptoms were assessed using the 15-item short form of the Geriatric Depression Scale and metabolic syndrome was defined according to the 2005 International Diabetes Federation. Covariates were social supports, negative life events, health behavior, education, cognitive function, anthropometric status, and others. Multiple logistic regression analyses were performed to determine the relationships between depressive symptoms and these variables.

Results: The prevalence of depressive symptoms (Geriatric Depression Scale-15 ≥6) and metabolic syndrome were 14.8% and 16.6%, respectively. Significant protective factors against depressive symptoms were higher education, more opportunity for drinking of alcohol, better social supports, and more walking daily. Metabolic syndrome was statistically associated with depressive symptoms (adjusted odds ratio = 1.32, 95% confidence interval = 1.03–1.68). Other risk factors significantly associated with depressive symptoms were sleep disturbance, visual or hearing impairment, and negative life events.

Conclusions: The present study showed an association between metabolic syndrome and depressive symptoms in ambulatory Japanese older people, as in western countries.

Key words: metabolic syndrome; depressive symptoms; community-dwelling older people; cross-sectional design; logistic regression analysis
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Introduction

The number of those aged 65 years or older in Japan is increasing and is now close to 30 million, with a proportion in the overall population of 22.7% (Cabinet Office Japan, 2010), suggesting that Japan is a super-aging society. Providing mental health care and good quality of life for the older people have become much more important and indispensable in the Japanese community. Late-life depressive disorders often arise in the context of psychosocial adversity, chronic medical diseases, and disability, and besides causing suffering and family disruption, they worsen medical outcomes (Alexopoulos, 2005). Risk factors leading to the development of late-life depression likely comprise complex interactions among genetic vulnerabilities, cognitive diathesis, age-associated neurobiological changes, and stressful events (Fiske *et al*., 2009).

Cerebrovascular disease, one of the risk factors in terms of medical disease, might predispose, precipitate, or perpetuate some late-life depressive syndromes (Alexopoulos *et al*., 1997). Vascular lesions may also increase older patients' vulnerabilities toward the development of subsequent depression, particularly in the face of life-event stressors or changes in social support (Krishnan *et al*., 2004). In addition, major depression has been reported to be highly prevalent among people with diabetes, and the prevalence varied greatly by diabetes types, showing that people with type 2 diabetes who were currently using insulin had a higher rate than people with type 1 diabetes (Li *et al*., 2008). Schleifer *et al*. (1989) found that among hospitalized patients after myocardial infarction, 18% were suffering from major depression, and another 27% were affected by a minor depressive syndrome.

Also, the risks for cardiovascular disease and diabetes are increased in the centrally obese patient (Klein *et al*., 2002; Eckel *et al*., 2010), which is related to the metabolic syndrome (MetS), a widely recognized concept around the world and also a lifestyle-related disease that includes visceral obesity, lipid abnormality, hypertension, and type 2 diabetes.

Before, there have been several reports of a positive association between depression/depressive symptoms and MetS (Foley *et al*., 2010), but others have reported finding no associations (Hildrum *et al*., 2009; Zeman *et al*., 2010). Also, positive associations have been reported in only male (Gil *et al*., 2006; Muhtz *et al*., 2009, 2008; Almeida *et al*., 2009; Takeuchi *et al*., 2009a, Takeuchi *et al*., 2009b) and in only female populations (Laudisio *et al*., 2009; Muhtz *et al*., 2009). These controversial results might result from differing numbers of subjects, a wide range of age groups, different races, and varying study designs (cross-sectional, longitudinal, etc.).

Because of this situation, the object of our study was to confirm an association between depressive symptoms and MetS in Japanese community-living older people, especially those who are able to walk independently.

Materials and methods

Participants

Data were from the baseline results of the Fujiwara-kyo study, which is a prospective cohort study on successful aging in Japanese community-dwelling independent older people 65 years of age or older (Okamoto *et al*., 2010). The entry criteria were that subjects were living in their own homes and able to walk independently. We carried out self-administered questionnaire surveys, measurements, and blood tests on 4427 voluntary subjects in northwestern Nara prefecture (the cities of Nara, Kashihara, Yamatokoriyama, and Kashiba) during the period from June 2007 to October 2008. These areas are near Osaka prefecture, within 25–40 min by public transportation from central Osaka, and they play roles as satellite cities with some rural zones. The proportion of this age group in these areas was between 16.9% and 22.2% (the mean value for Japan as a whole was 22.1% in 2008). Recruitment was performed by local resident associations and elderly clubs in target areas. After confirming missing data for gender, age, and disease history, valid data from 3796 subjects (85.7%) were obtained. This study was approved by the Ethical Review Board of Nara Medical University. Written informed consent was obtained from all subjects prior to their participation in the baseline examination of the Fujiwara-kyo study.

Assessment of depressive symptoms

Depressive symptoms were assessed using the 15-item short form of the Geriatric Depression Scale (GDS-15) (Sheikh and Yesavage, 1986). In previous validation studies, a score of 6 or higher suggested probable clinical depression in older Japanese (Niino *et al*., 1991).

Definition of metabolic syndrome

We defined the metabolic syndrome according to the 2005 International Diabetes Federation criteria

(Alberti *et al.*, 2006) as consisting of central obesity (waist circumference for Japanese population, ≥90 cm in men and ≥80 cm in women) plus any two of these four components: serum triglycerides, ≥150 mg/dL or specific treatment for this lipid abnormality; high-density lipoprotein (HDL) cholesterol, <40 mg/dL in men and <50 mg/dL in women or specific treatment for this lipid abnormality; systolic blood pressure, 130 mmHg and/or diastolic blood pressure 85 mmHg or treatment for previously diagnosed hypertension; and fasting plasma glucose, 100 mg/dL or treatment for previously diagnosed type 2 diabetes.

Assessment of other variables

Sociodemographic variables including gender, age group (65–69, 70–74, 75–79, 80 years old and above), length of education (≤9 or ≥10 years), and social supports were assessed. Social supports were evaluated with the Jichi Medical School Social Support Scale (Tsutsumi *et al.*, 2000; Tsutsumi, 2005), which was developed as a 28-item questionnaire (eight items for support from spouse and 10 items each for family and friends) measuring availability of social support for community residents. Each cutoff point of the three subscales (spouse, family, and friends) of Jichi Medical School Social Support Scale was set at the mean value in this analysis for grouping into two categories (better than average or worse than average support groups). Health behavior variables included alcohol use (none, rarely to 1–2 days per week, 2 days per week), cigarette smoking (current or noncurrent), the time spent walking per day (<30, ≥30 min, including household affairs), and body mass index (BMI, kg/m^2). Difficulties with vision and hearing in daily life were assessed using the 15D, a fifteen-dimensional self-administered measure of health-related quality of life (Sintonen, 1994).

Cognitive function was evaluated using the Mini-Mental State Examination, and persons with a score of less than 24 were defined as cognitively impaired (Folstein *et al.*, 1975; Maki *et al.*, 2000). The Pittsburgh Sleep Quality Index (Buysse *et al.*, 1989) was used to evaluate subjective sleep quality over the previous month, with higher scores indicating worse sleep quality. The Pittsburgh Sleep Quality Index has confirmed reliability and validity in Japan, using a cutoff point of 5.5 in the global score (Doi *et al.*, 2000). A dental examination was also carried out (Okamoto *et al.*, 2010).

Life events

Subjects were asked whether they had experienced any of the four severe key life events (death of a partner or child, serious problem in a relationship with relatives, decrease in income, or deteriorating environment in the neighborhood, such as noise and human relationships) during the 6 months before the baseline examination.

Statistical analyses

Demographic differences between subjects with and without depressive symptoms were compared using the chi-square, Student's t-test and Mann–Whitney *U*-tests. Logistic regression analysis was used to evaluate the association between depressive symptoms and possible risk or protective factors. First, univariate regression analysis was performed (model 1). Second, age, gender, and MetS were adjusted for (model 2). Finally, identified significant variables (significance level of $p < 0.1$) were then mutually adjusted (adjusted odds ratio, AOR) using a forced entry method (model 3). The null hypothesis was rejected when the *p*-value was less than 0.05. All statistical analyses were carried out with SPSS Version 16.0 for Windows.

Results

Subjects for analysis were 3796 community-dwelling independent older people aged 65–93 years (1911 men, 72.6 ± 5.3 years; and 1885 women, 72.2 ± 5.1 years, mean ± standard deviation). The prevalence of depressive symptoms (GDS-15 ≥6) was 14.8%, and there was no statistically significant difference in gender (13.8% in men and 15.8% in women, $p = 0.100$). The mean GDS score was statistically higher in women (3.2 ± 2.7) than in men (2.8 ± 2.5) ($p < 0.001$). The prevalence of the MetS was 16.6%, showing a statistically significant difference in gender (14.6% in men and 18.7% in women, $p < 0.001$)

Table 1 shows the baseline characteristics of subjects with and without depressive symptoms. Depressive persons had significantly lower education, more severe sleep disturbance, less drinking of alcohol, fewer social supports, more impaired vision or hearing, less walking, lower cognitive function, and more stressful life events than did nondepressive persons ($p < 0.01$). There were also no significant differences but higher percentages of MetS (depressive 19.3% versus nondepressive 16.2%, $p = 0.075$) and of more elevated fasting blood sugar (depressive 103.6 versus 101.3 mg/dl; $p = 0.095$) in depressive persons. No statistically significant differences in age, gender, current smoking, remaining teeth, or other physical examinations and blood test results (triglycerides, HDL cholesterol, and HbA_{1c}) were

Table 1 Demographic characteristics of participants ($N = 3796$)

		Depressed GDS ≥ 6 ($N = 561$)		Non-depressed GDS < 6 ($N = 3235$)		p-value
Characteristic		N	(%)	N	(%)	
Age (years)						0.33[a]
	65–69	183	32.6	1095	33.8	
	70–74	198	35.3	1113	34.4	
	75–79	110	19.6	696	21.5	
	80 and above	70	12.5	331	10.2	
Gender						0.10[a]
	Male	264	47.1	1647	50.9	
	Female	297	52.9	1588	49.1	
Metabolic syndrome		108	19.3	524	16.2	0.08[a]
		mean	(SD)	mean	(SD)	
BMI (kg/m^2)		22.9	3.2	22.9	3.0	0.80[c]
Waist circumference (cm)		79.9	9.6	79.5	9.2	0.42[b]
Systolic BP (mmHg)		142.4	21.4	143.4	20.2	0.29[b]
Diastolic BP (mmHg)		75.5	11.8	76.2	11.2	0.20[b]
Triglycerides (mg/dl)		126.7	73.2	124.4	67.9	0.46[b]
HDL cholesterol (mg/dl)		58.8	14.7	59.1	14.9	0.59[b]
Glucose (mg/dl)		103.6	30.4	101.3	27.1	0.10[c]
HbA1c (%)		5.3	0.7	5.3	0.7	0.25[b]
		N	(%)	N	(%)	
Education (years)						<0.001[a]
	≤9	195	34.8	867	26.8	
	≥10	366	65.2	2368	73.2	
Sleep disturbance		305	54.4	1002	31.0	<0.001[a]
Curent smoking		53	9.4	294	9.1	0.81[a]
Alcohol						<0.001[a]
	None	307	54.7	1401	43.3	
	Rarely 1–2 days/week	99	17.6	677	20.9	
	>2days/week	155	27.6	1157	35.8	
Above average social support						
	Spouse	337	60.1	2341	72.4	<0.001[a]
	Other family	262	46.7	2034	62.9	<0.001[a]
	Friends	229	40.8	1920	59.4	<0.001[a]
Visual impairment		31	5.5	57	1.8	<0.001[a]
Hearing impairment		93	16.6	291	9.0	<0.001[a]
Walking per day (≥30 min)		487	86.8	3000	92.7	<0.001[a]
Low cognitive function (MMSE score < 24)		40	7.1	146	4.5	<0.01[a]
Remaining teeth ≥ 20		305	54.4	1814	56.1	0.46[a]
Life events						
	Bereavement	40	7.1	109	3.4	<0.001[a]
	Kinship trouble	72	12.8	159	4.9	<0.001[a]
	Income decrease	248	44.2	956	29.6	<0.001[a]
	Poor living conditions	53	9.4	135	4.2	<0.001[a]

BMI, Body mass index; BP, Blood pressure; HDL, High-density lipoprotein; MMSE, Mini-mental state examination.
[a]Chi-square test.
[b]Student's t-test.
[c]Mann–Whitney U-test.

Table 2 Logistic regression analyses between depressive symptoms and variables

		Model 1			Model 2			Model 3		
		Odds ratio	(95% CI)	*p*-Value	Odds ratio	(95% CI)	*p*-value	Odds ratio	(95% CI)	*p*-value
Variables										
Age (years)										
	65–69	1	—	—	—	—	—	1	—	—
	70–74	1.06	(0.86–1.32)	0.57	—	—	—	1.00	(0.79–1.26)	0.98
	75–79	0.95	(0.73–1.22)	0.67	—	—	—	0.80	(0.61–1.06)	0.12
	80 and above	1.27	(0.94–1.71)	0.13	—	—	—	0.94	(0.67–1.32)	0.71
Gender										
	Male	1	—	—	—	—	—	1	—	—
	Female	1.17	(0.98–1.40)	0.09	—	—	—	0.95	(0.75–1.21)	0.68
Metabolic syndrome (MetS)		1.23	(0.98–1.55)	0.07	—	—	—	1.32	(1.03–1.68)	<0.05
Education (years)										
	≤9	1	—	—	1	—	—	1	—	—
	≥10	0.69	(0.57–0.83)	<0.001	0.70	(0.58–0.85)	<0.001	0.78	(0.64–0.97)	< 0.05
Sleep disturbance		2.66	(2.21–3.19)	<0.001	2.66	(2.22–3.20)	<0.001	2.22	(1.83–2.70)	<0.001
Current smoking		0.96	(0.71–1.30)	0.79	0.88	(0.64–1.21)	0.42		Not entered	
Alcohol										
	None	1	—	—	1	—	—	1		—
	Rarely ~ 1–2 days/week	0.67	(0.52–0.85)	<0.01	0.66	(0.51–0.84)	<0.01	0.66	(0.51–0.86)	<0.01
	>2 days/week	0.61	(0.50–0.75)	<0.001	0.59	(0.46–0.75)	<0.001	0.61	(0.48–0.79)	<0.001
Above average social support										
	Spouse	0.58	(0.48–0.69)	<0.001	0.56	(0.45–0.69)	<0.001	0.69	(0.55–0.87)	<0.01
	Other family	0.52	(0.43–0.62)	<0.001	0.49	(0.40–0.59)	<0.001	0.61	(0.50–0.75)	<0.001
	Friends	0.47	(0.39–0.57)	<0.001	0.44	(0.36–0.53)	<0.001	0.53	(0.43–0.65)	<0.001
Visual impairment		3.26	(2.09–5.10)	<0.001	3.21	(2.05–5.02)	<0.001	2.42	(1.49–3.95)	<0.001
Hearing impairment		2.01	(1.56–2.59)	<0.001	2.04	(1.57–2.64)	<0.001	1.81	(1.37–2.40)	<0.001
Walking per day (≥30 min)		0.52	(0.39–0.68)	<0.001	0.53	(0.40–0.70)	<0.001	0.58	(0.43–0.79)	<0.001
Low cognitive function (MMSE score < 24)		1.62	(1.13–2.33)	<0.01	1.63	(1.13–2.35)	<0.01	1.30	(0.87–1.93)	0.20
Remaining teeth ≥20		0.93	(0.78–1.12)	0.45	0.96	(0.80–1.16)	0.66		Not Entered	
Life events										
	Bereavement	2.20	(1.52–3.20)	<0.001	2.09	(1.43–3.06)	<0.001	1.24	(0.81–1.91)	0.32
	Kinship trouble	2.85	(2.12–3.82)	<0.001	2.88	(2.14–3.87)	<0.001	1.95	(1.41–2.70)	<0.001
	Income decrease	1.89	(1.57–2.27)	<0.001	1.93	(1.61–2.32)	<0.001	1.67	(1.37–2.04)	<0.001
	Poor living conditions	2.40	(1.72–3.34)	<0.001	2.42	(1.74–3.37)	<0.001	1.67	(1.16–2.40)	<0.01

MMSE, Mini-mental state examination.

Model 1, univariable model; Model 2, adjusted for age, gender, and MetS; Model 3, multivariable model adjusted for age, gender, MetS, sleep status, smoking, alcohol use, social supports, visual, hearing, walking, cognitive function, and life events.

detected between those with and without depressive symptoms.

The results of logistic regression analyses between depressive symptoms and other variables are shown in Table 2. Crude odds ratio (OR) of MetS did not reach statistical significance in model 1 (OR = 1.23, 95% CI 0.98–1.55; $p = 0.073$). Next, to narrow down the variables, the model was adjusted for age, gender, and MetS (model 2), but significant variables were similar. Finally, we analyzed other identified variables except current smoking and remaining teeth in the forced entry method (model 3). MetS was statistically associated with depressive symptoms (AOR = 1.32, 95% CI 1.03–1.68, $p < 0.05$).

Other risk factors that significantly increased the prevalence of depressive symptoms were sleep disturbance (AOR = 2.22, 95% CI 1.83–2.70), visual or hearing impairment (AOR = 2.42, 95% CI 1.49–3.95; AOR = 1.81, 95% CI 1.37–2.40, respectively), and life events (kinship trouble, AOR = 1.95, 95% CI 1.41–2.70; income decrease, AOR = 1.67, 95% CI 1.37–2.04; and poor living conditions, AOR = 1.67, 95% CI 1.16–2.40). Bereavement ($p = 0.32$) and lower cognitive function ($p = 0.20$) did not show statistical significance any longer. Significant protective factors against depressive symptoms were higher education (AOR = 0.78, 95% CI 0.64–0.97), alcohol intake (rarely ~1–2 days per week AOR = 0.66, 95% CI 0.51–0.86; more than 2 days per week AOR = 0.61, 95% CI 0.48–0.79), better social supports (spouse, AOR = 0.69, 95% CI 0.55–0.87; other family, AOR = 0.61, 95% CI 0.50–0.75; and friends, AOR = 0.53, 95% CI 0.43–0.65), and more walking per day (AOR = 0.58, 95% CI 0.43–0.79).

Discussion

The prevalence of depressive symptoms in community-dwelling Japanese older people has been reported elsewhere by using some self-completed questionnaires. Lee and Shinkai (2005) showed that the rates for depressive symptoms were 19.8% (men, 16.4% and women, 22.0%) of 1495 persons using the GDS-15. Fujisawa *et al.* (2005) reported 23.8% depressed older people defined with the GDS-15 in a provincial community (146 men and 236 women). Aihara *et al.* (2011) investigated 887 community-dwelling older people by using the GDS-5 and found that the prevalence of depressive symptoms was 12.9%. Using the 20-item standard form of the Center for Epidemiological Studies Depression scale, Oishi *et al.* (2009) described a prevalence of depressive states in the older people at 30.1% (men, 29.3% and women, 30.8%). Yokoyama *et al.* (2010) reported that the presence of depression among Japanese older people (1765 men and 2263 women) stood at 13.8% (men, 11.1% and women, 16.0%) by means of the 11-item short form Center for Epidemiological Studies Depression scale. Our prevalence of depressive symptoms of 14.8% (13.8% in men and 15.8% in women) was lower than these previously reported ranges. One reason for our lower prevalence may be that our subjects were a healthier group of Japanese community older people due to our entry criteria.

The prevalence of MetS according to the International Diabetes Federation criteria in Japan was reported by the Hisayama study (Doi *et al.*, 2009) to be 13.4% in 1050 men and 34.5% in 1402 women (mean age ± SD; men 58 ± 11 years, women 59 ± 11 years). Also,

Table 3 Previous and present studies of association between depressive symptoms and metabolic syndrome

Study (year)	*N* (sex)	Age range (mean ± SD)	Measure of depressive symptoms	Association between MetS and depressive symptoms (95% CI)
Vogelzangs *et al*. (2007a)	867 (M + F)	≥65 years (74.1 ± 6.6)	CES-D	OR, 1.20 per SD increase (1.02–1.41)
Vogelzangs *et al*. (2007b)	2917 (M + F)	70–79 years (73.6 ± 2.9)	CES-D	OR, 1.11 per SD increase in white (1.01–1.23)
Almeida *et al*. (2009)	12 066 (M)	65–84 years (72.1 ± 4.4)	ICD-10	HR, 2.37 (1.60–3.51)
Laudisio *et al*. (2009)	353 (M + F)	≥75 years	GDS (30-item)	β coefficient, 2.14 in F (0.14–4.14)
Akbaraly *et al*. (2011)	4446 (M + F)	65–91 years	CES-D	OR, 1.73 in 65–70 years (1.02–2.95)
Vogelzangs *et al*. (2011)	823 (M + F)	≥65 years	CES-D	MetS(-), waist circumference OR, 1.28 per SD (1.05–1.56)
Current Study	3796 (M + F)	65–93 years (M, 72.6±5.3; F, 72.2 ± 5.1)	GDS (15-item)	OR, 1.32 (1.03–1.68)

MetS, metabolic syndrome; M, Male; F, Female; CES-D, Center for Epidemiological Studies-Depression Scale; OR, odds ratio; GDS, Geriatric Depression Scale; HR, hazard ratio; ICD-10, International Statistical Classification of Diseases and Related Health Problems, 10th Revision. NA, not applicable.

Takeuchi *et al.* (2009a) showed that the prevalence of MetS was 12.2% in 1215 Japanese male workers (20–67 years). Strict comparison is complicated because of the different ages of the subjects. The prevalence in men (14.6%) was similar, and women (18.7%) had a much lower percentage of MetS in our study, but the reason is unclear.

Until now, there have been four English reports from Japan (three cross-sectional and one prospective) investigating the association of MetS and depressive symptoms. However, the age range of participants in those studies was broad (young adult to older people) and two reports were limited to males. Takeuchi *et al.* (2009a) reported a positive association between MetS and depression (AOR 1.91, 95% CI 1.01–3.60, 1215 men, 20–67 years old) in a cross-sectional study (Takeuchi *et al.*, 2009a) and obtained a similar result (AOR 2.14, 95% CI 1.10–4.17, 956 men, 20–66 years old) in a 1-year cohort study (Takeuchi *et al.*, 2009b). Nishina *et al.* (2011) described the multivariable-adjusted OR of increments of 1SD in depression scores as 1.48 (95% CI 1.19–1.84) for MetS in men (825 men and 788 women, 30–79 years old). Kimura *et al.* (2011) could not find MetS associated with depressive status in 458 municipal employees (285 men and 173 women, 21–67 years old).

One speculation about the reason why two reports could not show a positive association in both genders (Nishina *et al.*, 2011; Kimura *et al.*, 2011) may be because of the low numbers of subjects. Kimura *et al.*, (2011) reported that the number of subjects might not be sufficiently large to detect a modest association. In fact, the 49 men and 19 women who suffered from MetS were smaller than in the other reports. Also, Nishina *et al.* (2011) described a negative association in women and that the multivariable-adjusted OR of increments of 1SD in depression scores was 1.10 (95% CI 0.66–1.83). However, because the OR exceeded one, this might mean that insufficient sample size had influenced the significance of this result also.

To our knowledge, the present study is the first report about Japanese community-dwelling older people to indicate that MetS is associated significantly with depressive symptoms, after adjustment of covariates such as age, gender, education, sleep, smoking, alcohol use, several social supports, vision, hearing, walking, cognitive function, remaining teeth, and negative life events. Other significant risk factors for depressive symptoms are sleep disturbance, visual or hearing impairment, and negative life events (kinship trouble, income decrease, and poor living conditions). In addition, significant protective factors are higher education, alcohol intake, better social supports (spouse, other family, and friends), and more daily walking.

Recently, there have been six reports (three cross-sectional and three cohort studies) (Laudisio *et al.*, 2009; Vogelzangs *et al.*, 2007a; Vogelzangs *et al.*, 2007b; Vogelzangs *et al.*, 2011; Almeida *et al.*, 2009; Akbaraly *et al.*, 2011) about MetS and depressive syndromes limited to the older people (≥65 years) in western countries (Table 3). Our result was in accordance with those. Strict comparison is difficult because of the different prevalence of depressive symptoms and MetS in various countries, but the present study showed a statistically significant OR for MetS with depressive symptoms in the older people (65–93 years) regardless of gender. Although various factors are related to depressive symptoms in the older people, preventing MetS by health education might contribute to managing depressive symptoms in older Japanese.

p-value	Study design	Prevalence of MetS (%) at baseline	Prevalence of depressive symptoms	Country
0.03	Cross-sectional	24.5%	20.6%	Netherlands
0.03	Cross-sectional	38.6%	4.6%	USA
<0.001	Cohort	3.0%	4.0% (new onset)	Australia
0.036	Cross-sectional	39.0%	NA	Italy
0.04	Cohort	12.9%	18.6% (new onset)	France
0.01	Cohort	28.6%	20.4% (baseline) 26.0% (new onset)	Italy
<0.05	Cross-sectional	16.6%	14.8%	Japan

One of the possible mechanisms connecting MetS and depressive symptoms may be increased levels of inflammatory markers, such as interleukin-6 and C-reactive protein (Capuron *et al*., 2008). Also, well-functioning older persons with high plasma levels of interleukin-6, tumor necrosis factor-alpha, and C-reactive protein had a significantly higher risk of exhibiting depressed mood (Penninx *et al*., 2003). However, to address these issues, there needs to be further investigation in a follow-up study.

There are several limitations of the present study. First, a self-report scale was used to assess depressive symptoms and not a structured clinical interview for the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders. However, the GDS has been widely used in epidemiological settings in Japan and is easy to use for screening, which is useful for health guidance. Second, the analysis of this study was cross-sectional and limited to the baseline data of a prospective cohort study. This study is now on-going, and further analyses are needed to address a causal link between MetS and depressive symptoms. Finally, there was no information on history of depression and current medication for depression. A follow-up study 5 years after our baseline examination is scheduled to gather that information.

Despite these limitations, many sociodemographic factors, health status, social supports, and stresses of life were included in this study, and a large sample of community-dwelling older people provided sufficient statistical power to examine the association between depressive symptoms and MetS.

Conclusion

We found that MetS is associated with depressive symptoms in Japanese older people who are able to walk independently. We also showed that sleep disturbance, visual or hearing impairment, and negative life events could be risk factors, and that higher education, more opportunity for drinking alcohol, better social supports, and more daily walking might be protective factors. Further studies should confirm whether preventing metabolic syndrome might contribute to managing depressive symptoms in Japanese older people.

Conflict of interest

None of the authors have any conflicts of interest associated with this article.

Key points

- Metabolic syndrome is a risk factor for depressive symptoms in community-dwelling older people who live in their own homes and are able to walk independently.
- Other risk factors are sleep disturbance, visual or hearing impairment, and negative life events (kinship trouble, income decrease, and poor living conditions).
- Protective factors against depressive symptoms are higher education, more opportunity for drinking alcohol, better social support, and more daily walking.

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