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ONLINE SUPPLEMENT

Title: White-coat and Masked Hypertension are Associated with Carotid Atherosclerosis in a General Population: the Hisayama Study

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Supplemental Methods

Other Risk Factor Measurements

Each participant completed a self-administered questionnaire covering medical history, including treatment for hypertension, diabetes mellitus, and hyperlipidemia, smoking habits, alcohol intake, and regular exercise. Smoking habits and alcohol intake were classified into currently habitual or not. The subjects engaging in sports or other forms of exertion ≥3 times a week during their leisure time made up a regular exercise group. Body height and weight were measured in light clothing without shoes, and the body mass index (kg/m^2) was calculated. Serum total and high-density lipoprotein (HDL) cholesterol levels were determined enzymatically. Blood glucose levels were measured by the hexokinase method. Diabetes mellitus was determined by medical history, plasma glucose levels (fasting glucose level ≥7.0 mmol/L or postprandial glucose level ≥11.1 mmol/L), or a 75-g oral glucose tolerance test using the 1998 World Health Organization criteria.[1] History of cardiovascular disease was defined as any preexisting events of stroke or coronary heart disease, including myocardial infarction and coronary intervention. All cardiovascular events were adjudicated on the basis of physical examinations and a review of all available clinical information including medical records and imaging.

Supplemental Table I. Baseline Characteristics of Included and Excluded Participants in the Study

Variables	Included participants (n=2,915)	Excluded participants (n=461)
Age, years	62.7 ± 11.8	71.6 ± 15.6†
Male, %	43.5	41.4
Clinic systolic blood pressure, mmHg	131.4 ± 18.8	136.0 ± 22.6†
Clinic diastolic blood pressure, mmHg	79.3 ± 10.7	78.4 ± 12.7
Antihypertensive medication, %	31.3	37.3*
Diabetes mellitus, %	16.9	14.1
Total cholesterol, mmol/L	5.43 ± 0.91	5.13 ± 1.11†
HDL cholesterol, mmol/L	1.73 ± 0.46	1.63 ± 0.49†
Lipid-lowering medication, %	15.6	13.9
Body mass index, kg/m^2	23.1 ± 3.4	21.9 ± 3.7†
Current drinking, %	49.2	31.8†
Current smoking, %	19.1	22.2
Regular exercise, %	12.5	5.0
History of cardiovascular disease, %	5.2	14.8†

Abbreviations: HT, hypertension; HDL, high density lipoprotein.
All values are given as the means ± SD or as a percentage.
*$p<0.05$, †$p<0.001$.

Supplemental Table II. Multivariable-adjusted Geometric Average of Mean and Maximum Intima-media Thickness According to Blood Pressure Category among Participants without and with Antihypertensive Medication

Outcomes	Normotension	White-coat HT	Masked HT	Sustained HT
Mean intima-media thickness				
No antihypertensive medication				
No. of participants	1,189	132	320	363
Geometric average (95%CI)*	0.69 (0.69-0.70)	0.73 (0.71-0.75)†	0.73 (0.72-0.75)‡	0.74 (0.73-0.75)‡
Antihypertensive medication				
No. of participants	185	68	319	339
Geometric average (95%CI)*	0.71 (0.69-0.72)	0.70 (0.68-0.73)	0.75 (0.73-0.76)‡	0.74 (0.73-0.76)‡
Maximum intima-media thickness				
No antihypertensive medication				
No. of participants	1,189	132	320	363
Geometric average (95%CI)*	1.13 (1.11-1.16)	1.32 (1.24-1.40)‡	1.24 (1.19-1.29)‡	1.26 (1.21-1.30)‡
Antihypertensive medication				
No. of participants	185	68	319	339
Geometric average (95%CI)*	1.19 (1.13-1.25)	1.28 (1.18-1.39)**	1.27 (1.23-1.33)‡	1.30 (1.26-1.36)‡

Abbreviations: HT, hypertension; CI, confidence interval.
*Adjusted for age, sex, diabetes mellitus, total cholesterol, high-density lipoprotein cholesterol, body mass index, smoking, drinking, exercise, and lipid-lowering medication.
**$p<0.05$, †$p<0.01$, ‡$p<0.001$ vs normotension without antihypertensive medication.

Supplemental Table III. Age- and Sex-adjusted Prevalence and Adjusted Odds Ratio of Carotid Wall Thickening and Carotid Stenosis According to Blood Pressure Category among Participants without and with Antihypertensive Medication

Outcomes	Normotension	White-coat HT	Masked HT	Sustained HT
Carotid wall thickening*				
No antihypertensive medication				
No. of cases / participants	487 / 1,189	86 / 132	210 / 320	222 / 363
Age- and sex-adjusted prevalence, %	49.8	66.1	62.4	58.2
Multivariable-adjusted odds ratio (95% CI)**	1.00 (reference)	2.08 (1.38-3.15)	1.66 (1.24-2.21)	1.42 (1.08-1.86)
Antihypertensive medication				
No. of cases / participants	116 / 185	48 / 68	228 / 319	254 / 339
Age- and sex-adjusted prevalence, %	58.9	63.0	57.9	63.1
Multivariable-adjusted odds ratio (95% CI)**	1.00 (reference)	1.33 (0.69-2.57)	1.24 (0.81-1.89)	1.51 (0.98-2.32)
Carotid stenosis†				
No antihypertensive medication				
No. of cases / participants	30 / 1,189	9 / 132	22 / 320	33 / 363
Age- and sex-adjusted prevalence, %	3.7	7.2	5.8	8.5
Multivariable-adjusted odds ratio (95% CI)**	1.00 (reference)	2.61 (1.16-5.86)	1.71 (0.93-3.12)	2.64 (1.52-4.59)
Antihypertensive medication				
No. of cases / participants	8 / 185	7 / 68	33 / 319	51 / 339
Age- and sex-adjusted prevalence, %	4.0	7.5	7.6	13.0
Multivariable-adjusted odds ratio (95% CI)**	1.00 (reference)	2.23 (0.75-6.59)	2.42 (1.07-5.45)	3.80 (1.72-8.38)

Abbreviations: HT, hypertension; CI, confidence interval.
*Maximum intima-media thickness >1.0mm. †Percent diameter stenosis ≥30%.
**Adjusted for age, sex, diabetes mellitus, total cholesterol, high-density lipoprotein cholesterol, body mass index, smoking, drinking, exercise, and lipid-lowering medication.

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RESEARCH ARTICLE Open Access

Elevated depressive symptoms in metabolic syndrome in a general population of Japanese men: a cross-sectional study

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Abstract

Background: Uncertainty still surrounds the association between metabolic syndrome (MetS) and depression. We aimed to evaluate the association between MetS and elevated depressive symptoms in a general Japanese population.

Methods: This is a cross-sectional survey of 3,113 community-dwelling individuals aged 40 years or over. MetS was defined according to the joint interim statement. MetS was diagnosed when a subject had three or more of the following components: 1) central obesity (waist circumference ≥90 cm for men, ≥80 cm in for women); 2) elevated blood pressure (≥130/85 mmHg or current use of antihypertensive medication); 3) hypertriglyceridemia (≥1.7 mmol/L); 4) low HDL cholesterol (< 1.0 mmol/L for men, < 1.3 mmol/L for women); and 5) elevated fasting plasma glucose (≥5.55 mmol/L or current use of antidiabetic medication). Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale (CES-D). The age- and multivariable-adjusted odds ratio (OR) and 95% confidence interval (CI) were estimated using a logistic regression model.

Results: Elevated depressive symptoms were observed in 4.3% of male and 6.3% of female participants. In men, the age-adjusted prevalence of elevated depressive symptoms was significantly higher in subjects with MetS than in those without (7.1% versus 3.6%, p = 0.04). The prevalence of elevated depressive symptoms rose progressively as the number of MetS components increased (3.5%, 3.6%, 5.8%, and 9.2% in male subjects with 0–1, 2, 3, and ≥4 components, respectively; p = 0.02 for trend). This association remained significant even after adjustment for age, marital status, history of cardiovascular disease, smoking habit, alcohol intake, and regular exercise. In women, on the other hand, there was no clear association between MetS and depressive symptoms.

Conclusions: MetS was associated with elevated depressive symptoms in a general population of Japanese men.

Keywords: Depressive symptoms, Metabolic syndrome, Population-based, Japanese

Background

Depression is an important cause of long-term disability and dependency and is responsible for 11.8% of years-lived-with-disability [1,2]. Effective prevention of the burdens associated with depression will require a strategy based on better knowledge of its risk factors. Recently, a systematic review of observational studies demonstrated a link between metabolic syndrome (MetS) and depressive symptoms [3]. However, current knowledge of the association between MetS and depressive symptoms was derived mainly from studies conducted in Western populations; so it is unclear to what extent these findings apply to Asian populations. The present cross-sectional study evaluates the association of MetS with depressive symptoms in a general population of Japanese.

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Methods

Study population and design

The Hisayama Study is a prospective cohort study of cerebro-cardiovascular diseases in a suburban community, the town of Hisayama, adjacent to of the city of Fukuoka, Japan [4-6]. Based on data from the national census, the age and occupational distributions in Hisayama have been almost identical to those in Japan as a whole since the 1960s [4]. As a part of this study, all 4330 residents of the town of Hisayama aged 40 years or older were invited to participate in a cross-sectional examination in 2007 and 2008. Among them, 3,376 residents consented to participate (participation rate 78.0%). After the exclusion of 263 subjects with missing data on depression or MetS, a total of 3,113 subjects were included in the present analysis.

Metabolic syndrome

Information on current use of antihypertensive and antidiabetic medications was collected using a self-administered questionnaire and confirmed using the consumer drug information by trained staff. Blood pressure was measured three times after the subject had rested for at least 5 minutes prior to each measurement using a semi-automatic device (BP-203 RVIIIB; Omron Healthcare) based on the cuff-oscillometric principle with the subject in the sitting position. The mean of the three measurements was used for the analysis. Waist circumference was measured at the umbilical level in a standing position by a trained staff member. Blood samples were collected from an antecubital vein after an overnight fast for the determination of serum lipids and plasma glucose levels. Serum total cholesterol, triglyceride, and high-density lipoprotein (HDL) cholesterol concentrations were determined enzymatically. Fasting blood glucose levels were measured by the glucose oxidase method. MetS was defined based on the joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity [7]. MetS was diagnosed when a subject had three or more of the following components: 1) central obesity (waist circumference ≥90 cm for men, ≥80 cm for women); 2) elevated blood pressure (≥130/85 mmHg or current use of antihypertensive medication); 3) hypertriglyceridemia (≥1.7 mmol/L); 4) low HDL cholesterol (< 1.0 mmol/L for men, < 1.3 mmol/L for women); and 5) elevated fasting plasma glucose (≥5.55 mmol/L or current use of antidiabetic medication).

Other covariates

Each participant completed a self-administered questionnaire covering marital status, medical history, smoking habit, alcohol intake, and exercise. The questionnaire was checked by trained interviewers. Marital status was classified as either having a spouse on a family register or not (e.g. single, divorced). A history of cardiovascular disease was defined as prior stroke (ICD10 codes I60, I61, I63 and I64) or coronary heart disease (I20 – I25) with or without coronary revascularization (coronary intervention or bypass surgery). A smoking habit was defined as current habitual smoking of 1 or more cigarettes per day. Alcohol intake was defined as current habitual drinking of at least once per month. Subjects who engaged in sports or other forms of exercise ≥3 times a week during their leisure time made up a regular exercise group.

Elevated depressive symptoms

Depressive symptoms were assessed using the Japanese, 20-item version of the Center for Epidemiologic Studies Depression Scale (CES-D) [8,9], the reliability of which has been validated [10]. Elevated depressive symptoms were defined as a CES-D score of ≥16 or current use of antidepressant medication defined based on the self-administered questionnaire and the consumer drug information.

Statistical analyses

In the present analysis, the key risk factor was MetS and its components, and the outcome was elevated depressive symptoms. All analyses were conducted separately for men and women. The prevalence of elevated depressive symptoms in each subgroup defined by MetS or its components was standardized for age distribution of the total study subjects by the direct method using 10-year age groupings. The association between components of Mets and elevated depressive symptoms was evaluated using an age-adjusted logistic regression model. The association of Mets and the number of its components with elevated depressive symptoms was evaluated using age- and multivariable-adjusted logistic regression models. The multivariable-adjusted models included age, marital status, history of cardiovascular disease, smoking habit, alcohol intake, and regular exercise as covariates. The differences in the association of MetS and the number of its components with elevated depressive symptoms between men and women were evaluated by adding interaction term(s) to the logistic regression models. $P < 0.05$ was considered statistically significant in all analyses. The SAS software package, version 9.2 (SAS Institute) was used for statistical analysis.

Ethical considerations

The study protocol was approved by Kyushu University Institutional Review Board for Clinical Research, and the procedures followed were in accordance with national

guidelines. All participants provided written informed consent.

Results

The baseline characteristics of subjects with and without MetS are shown by sex in Table 1. Subjects with MetS had higher values for waist circumference, systolic and diastolic blood pressures, serum total cholesterol, triglycerides and fasting plasma glucose; they also had lower levels of HDL cholesterol in both men and women. The frequencies of antihypertensive and antidiabetic medications were also higher in MetS subjects of both sexes. Women with MetS were older and less likely to be alcohol drinkers.

Elevated depressive symptoms were observed in 58 (4.3%) men and 111 (6.3%) women. Table 2 shows the age-adjusted prevalence and odds ratio [OR] for elevated depressive symptoms according to the presence of MetS components in men and women. The age-adjusted prevalence of elevated depressive symptoms was higher in men with low HDL cholesterol (age-adjusted OR 2.55 [95% CI 1.11-5.86]) and men with elevated fasting plasma glucose (1.90 [95% CI 1.06-3.42]). These associations remained significant even after controlling for age, marital status, history of cardiovascular disease, smoking habit, alcohol intake, and regular exercise (low HDL cholesterol: multivariable-adjusted OR 2.44 [95% CI 1.04-5.69], elevated fasting plasma glucose: 1.93 [95% CI 1.07-3.49]). In women, on the other hand, there were no clear associations between MetS components and depressive symptoms (all $p > 0.05$).

Table 3 shows the association of MetS with depressive symptoms in men and women. The age-adjusted prevalence of elevated depressive symptoms was significantly higher in men with MetS than in those without it (7.1% versus 3.6%; age-adjusted OR 1.78 [95% CI 1.03-3.08]). This association remained significant even after controlling for age, marital status, history of cardiovascular disease, smoking habit, alcohol intake, and regular exercise (multivariable-adjusted OR 1.82 [95% CI 1.05-3.15]). In women, on the other hand, there were no significant associations between MetS and depressive symptoms ($p = 0.10$; $p = 0.006$ for homogeneity between men and women).

The age-adjusted prevalence and adjusted OR for elevated depressive symptoms according to the number of MetS components are shown by sex in Table 4. In men, the age-adjusted prevalence rose with the number of MetS components: it was 3.5%, 3.6%, 5.8%, and 9.2% for subjects with 0–1, 2, 3, and ≥4 components, respectively ($p = 0.02$ for trend). A significant association was observed even after controlling for the aforementioned confounding factors ($p = 0.01$ for trend). When the number of MetS was used as a continuous variable, an increase in 1 component was associated with a 35% (95% CI 8-67%) increase in elevated depressive symptoms. In contrast to men, women showed no clear associations between the number of MetS components and

Table 1 Characteristics of men and women with and without metabolic syndrome

	Men			Women		
	MetS (−) (n = 965)	MetS (+) (n = 388)	P value	MetS (−) (n = 1261)	MetS (+) (n = 499)	P value
Age (years)	63 ± 12	62 ± 10	0.14	62 ± 13	67 ± 11	< 0.0001
Single or divorced (%)	11.7	11.6	0.95	27.5	31.9	0.07
History of cardiovascular disease (%)	8.4	10.6	0.21	2.6	4.8	0.02
Antihypertensive medication (%)	28.2	44.6	< 0.0001	23.2	50.1	< 0.0001
Antidiabetic medication (%)	7.2	17.0	< 0.0001	1.8	17.6	< 0.0001
Waist circumference (cm)	83.5 ± 7.2	92.6 ± 6.8	< 0.0001	81.3 ± 9.3	91.4 ± 9.3	< 0.0001
Systolic blood pressure (mmHg)	129 ± 17	144 ± 15	< 0.0001	125 ± 18	144 ± 16	< 0.0001
Diastolic blood pressure (mmHg)	79 ± 9	88 ± 9	< 0.0001	75 ± 10	84 ± 10	< 0.0001
Total cholesterol (mmol/L)	5.10 ± 0.87	5.34 ± 0.93	0.0001	5.57 ± 0.89	5.73 ± 0.93	0.0008
Triglycerides (mmol/L)	1.10(0.82–1.47)	2.02(1.47–2.84)	< 0.0001	0.93(0.69–1.23)	1.57(1.09–2.04)	< 0.0001
HDL cholesterol (mmol/L)	1.65 ± 0.42	1.39 ± 0.37	< 0.0001	1.95 ± 0.43	1.61 ± 0.42	< 0.0001
Fasting plasma glucose (mmol/L)	5.8 ± 1.2	6.7 ± 1.6	< 0.0001	5.3 ± 0.7	6.4 ± 1.5	< 0.0001
Smoking habit (%)	33.6	38.0	0.12	7.6	7.3	0.82
Alcohol intake (%)	68.0	71.4	0.22	33.7	26.7	0.004
Regular exercise (%)	13.7	12.9	0.70	10.1	12.6	0.12

MetS metabolic syndrome; *HDL* high-density lipoprotein.
Values are mean ± SD, median (interquartile range) or frequency.
The differences between subjects with and without MetS were tested by Wilcoxon tests for continuous variables and chi-square tests for categorical variables.

Table 2 Components of metabolic syndrome and elevated depressive symptoms in men and women

	N of cases/ participants	Age-adjusted prevalence (%)	Age-adjusted OR (95% CI)	P value
Men				
Central obesity				
No	34/912	3.6	Reference	
Yes	24/441	5.9	1.61 (0.94–2.77)	0.08
Elevated BP				
No	21/582	3.9	Reference	
Yes	37/771	4.9	1.26 (0.73–2.18)	0.41
Hypertriglyceridemia				
No	40/939	4.1	Reference	
Yes	18/414	4.8	1.17 (0.66–2.09)	0.60
Low HDL cholesterol				
No	51/1276	4.0	Reference	
Yes	7/77	8.3	2.55 (1.11–5.86)	0.03
Elevated FPG				
No	16/570	2.9	Reference	
Yes	42/783	5.5	1.90 (1.06–3.42)	0.03
Women				
Central obesity				
No	43/593	7.4	Reference	
Yes	68/1167	5.9	0.78 (0.53–1.16)	0.22
Elevated BP				
No	58/899	6.8	Reference	
Yes	53/861	6.2	0.91 (0.61–1.36)	0.65
Hypertriglyceridemia				
No	100/1471	6.8	Reference	
Yes	11/289	3.6	0.54 (0.28–1.01)	0.05
Low HDL cholesterol				
No	102/1607	6.3	Reference	
Yes	9/153	6.4	0.92 (0.45–1.85)	0.81
Elevated FPG				
No	71/1103	6.5	Reference	
Yes	40/657	6.3	0.93 (0.62–1.39)	0.71

OR odds ratio, 95% *CI* 95% confidence interval, *BP* blood pressure, *HDL* high-density lipoprotein, *FPG* fasting plasma glucose.
OR and P values were estimated using logistic regression models.

depressive symptoms (p = 0.17 for trend; OR 0.9 (95% CI 0.76-1.06) per 1 component increase; p = 0.04 for homogeneity between men and women).

Discussion

The present cross-sectional examination of a general population of Japanese demonstrated a higher prevalence of elevated depressive symptoms in male subjects with MetS compared to those without it. This association remained significant even after controlling for the effects of age, marital status, history of cardiovascular disease, smoking habit, alcohol intake, and regular exercise. Furthermore, the prevalence of elevated depressive symptoms rose with the number of MetS components. In female subjects, on the other hand, there was no clear association between MetS and depressive symptoms.

Although a number of observational studies have investigated the association between MetS and depressive symptoms, their conclusions have been inconsistent [11-29]. With regard to cross-sectional studies, a French study demonstrated elevated depressive symptoms in men and women with MetS [14]. The PPP-Bonita Study also showed close associations of MetS and its components with depressive symptoms in Finnish men and women [29]. With respect to longitudinal design research, the Whitehall II study demonstrated that the presence of MetS was associated with 38% increased risks of future depressive symptoms in men and women in London [16]. The Health in Men Study showed that MetS was a strong predictor of the future development of depression in elderly Australian men [17]. A positive association between MetS and the incidence of depression was also reported in an office-based study of 956 Japanese men [18]. On the other hand, a cohort study from France demonstrated no significant association between MetS and depressive symptoms in elderly subjects aged about 70–90 years old [24]. A recent systematic review and a meta analysis including all these studies, however, demonstrated a clear relationship between MetS and depression. Our findings from the Hisayama Study suggest that the concept of a link between MetS and depression is likely to be applicable to Japanese men.

Several population-based observational studies have reported the association between MetS and depression separately for men and women. A cross-sectional study in France demonstrated that depression and depressive symptoms were associated with MetS, irrespective of gender [14]. A cross-sectional study in Poland showed that MetS was observed more frequently among male subjects with depressive symptoms than those without, while there were no associations among women [12]. A cross-sectional study in the United States reported that women with a history of major depressive episode were twice as likely to have metabolic syndrome compared with those without such a history, but men with history of depression were not significantly more likely to have MetS [11]. A cohort study in Finland found that MetS was not associated with depression or anxiety in either men or women [13]. Therefore, there has been significant inconsistency in gender differences in the link between MetS and depression in Western populations. With regard to Asian populations, on the other hand, a cohort study of Japanese male employees showed a

Table 3 Metabolic syndrome and elevated depressive symptoms in men and women

	N of cases/participants	Age-adjusted			Multivariable-adjusted*	
		Prevalence (%)	OR (95% CI)	P value	OR (95% CI)	P value
Men						
MetS (−)	35/965	3.6	Reference		Reference	
MetS (+)	23/388	7.1	1.78 (1.03–3.08)	0.04	1.82 (1.05–3.15)	0.03
Women						
MetS (−)	87/1261	7.0	Reference		Reference	
MetS (+)	24/499	5.2	0.66 (0.41–1.06)	0.08	0.67 (0.42–1.08)	0.10

MetS metabolic syndrome, *OR* odds ratio, *95% CI* 95% confidence interval.
OR and P values were estimated using logistic regression models.
*Adjusted for age, marital status, history of cardiovascular disease, smoking habit, alcohol intake and regular exercise.

positive relationship between MetS and depression [18]. A cross-sectional study of Japanese subjects in Takarazuka City demonstrated that the mean depression score was higher for men with MetS than those without it, while depression was not associated with MetS in women [25]. In the present study of Japanese subjects, MetS was associated with elevated depressive symptoms in men but not in women. In Asian populations, MetS may be associated with depressive symptoms only in men.

One of the mechanisms underlying the association between MetS and depressive symptoms is thought to be the stress-induced hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis, which is common in depression [30-32] and could lead to metabolic alterations [33-35]. Chronic stress has also been shown to increase the risk of metabolic disorders through elevated sympathetic activity [36]. Another potential mechanism is that cerebral small vessel disease associated with MetS [37] can increase the risk of late-life depression [38,39]. It is also possible that behavioral factors associated with depressive symptoms, such as physical inactivity and poor diet, contribute to central adiposity and metabolic disorders.

Another important finding from the present analysis is the lack of associations between MetS and depressive symptoms in women. This finding is consistent with a previous cross-sectional study. The SOPKARD project demonstrated clear associations between MetS and depressive symptoms in Polish men but not in Polish women [12]. The reason for this discrepancy has not been clearly resolved, but it may be attributable to heterogeneity in genetic factors, hormonal factors, socioeconomic factors and social roles between men and women.

There were several limitations to this study. Because of the cross-sectional nature of the study, we were unable to determine whether or not there was a causal association between MetS and the development of depressive symptoms. In addition, we were unable to address the potential mechanisms underlying the reported associations, the self-reported covariates had somewhat limited accuracy, and the study lacked definite diagnosis

Table 4 The number of metabolic syndrome components and elevated depressive symptoms in men and women

	N of cases/participants	Age-adjusted			Multivariable-adjusted*	
Number of MetS components		Prevalence (%)	OR (95% CI)	P trend	OR (95% CI)	P trend
Men						
0-1	20/567	3.5	Reference		Reference	
2	15/398	3.6	0.80 (0.44–1.45)		0.84 (0.46–1.55)	
3	12/250	5.8	1.17 (0.61–2.25)		1.20 (0.62–2.31)	
≥4	11/138	9.2	2.43 (1.22–4.86)	0.02	2.47 (1.22–4.96)	0.01
Women						
0-1	56/782	7.4	Reference		Reference	
2	31/479	6.3	1.03 (0.67–1.58)		1.05 (0.68–1.62)	
3	15/360	4.4	0.58 (0.33–1.01)		0.56 (0.32–0.99)	
≥4	9/139	7.5	1.01 (0.50–2.06)	0.12	1.10 (0.54–2.25)	0.17

MetS metabolic syndrome, *OR* odds ratio, *95% CI* 95% confidence interval.
OR and P values were estimated using logistic regression models.
*Adjusted for age, marital status, history of cardiovascular disease, smoking habit, alcohol intake and regular exercise.

of depression based on structured interviews with psychiatrists using standard criteria.

Conclusions

In conclusion, MetS was associated with elevated depressive symptoms in a general population of Japanese men. Screening of depressive symptoms in men with MetS is likely to aid in the early detection and treatment of depression, and might be able to provide additional protection against the enormous burden of mental disorders in Japan.

Abbreviations

MetS: Metabolic syndrome; CES-D: Center for epidemiologic studies depression scale; HDL: High-density lipoprotein; OR: Odds ratio; CI: Confidence interval; HPA: Hypothalamic-pituitary-adrenal.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AS conducted the statistical analyses, wrote the manuscript, and reviewed and edited the manuscript. AS is the guarantor of this work, had full access to all data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. HA contributed to discussion and reviewed and edited the manuscript. TN, TO and YD contributed to discussion. YH brushed up the accuracy of data. MF, JH, KY, YG, TK and SK contributed to discussion. YK is responsible for overall management of the Hisayama Study, and reviewed and edited the manuscript. All authors read and approved the final manuscript.

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【資　料】

「非感染性疾患予防：身体活動への有効な投資」日本語版の紹介

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【要約】「非感染性疾患予防：身体活動への有効な投資」は，「身体活動のトロント憲章：世界規模での行動の呼びかけ（2010 年 5 月）」を補完する資料として，2011 年 2 月に公刊された。本資料も，国際身体活動健康学会の協議会の 1 つである身体活動の世界規模での支援活動協議会および有識者により提案されたものである。第 4 回国際身体活動公衆衛生会議（2012 年 10-11 月，シドニー）終了後，本会議への出席者を中心に日本語版への翻訳を行った。本稿では，資料作成の関連情報や背景，翻訳の手続き，資料の内容について紹介した。

この新しい資料では，有効性が確認されたエビデンスや世界中で応用することが可能な身体活動推進のための 7 つの投資が提案された：1）「学校ぐるみ」のプログラム，2）歩行，自転車，公共交通の利用を優先する交通政策・システム，3）余暇身体活動，レクリエーションおよび移動に伴う歩行・自転車利用を，生涯にわたって公平かつ安全に行えるような機会を提供するための都市計画に関する規制およびインフラ，4）プライマリ・ヘルスケアシステムへの身体活動および非感染性疾患予防の統合，5）身体活動に関する意識を高め，社会規範を変えるためのマスメディア活用を含む一般社会に向けた教育，6）多数の場面や機関を巻き込み，地域の積極的な関与と資源の動員・統合による地域社会全体でのプログラム，7）「スポーツ・フォー・オール」を奨励し，生涯にわたる参加を促すスポーツシステムとスポーツプログラム。非感染性疾患の負担を減らし，生活の質（QOL）や生活環境を改善するために，十分な資源の下，多くの国において国民全体に対して身体活動促進のための 7 つの投資を実行すべきであることが強調されている。日本語版および原（英語）版を付表として添付したので，「トロント憲章」と同様にこの新しい資料が広く活用されることを期待する。

Key words：非感染性疾患予防，投資，身体活動推進，トロント憲章

1．緒　　言

今日，身体不活動は，心疾患，脳卒中，糖尿病，がんなどの非感染性疾患による死亡原因の第 4 位となっており，全世界で毎年 300 万人以上の予防できるはずの命が奪われている[1)]。身体不活動の割合は多くの国々で増加傾向にあり，非感染性疾患の蔓延と強く関係しているため，あらゆる国においてその対策が大きな課題となっている[2)]。

これらの課題解決に向けて，2010 年 5 月にカナダのトロントで開催された第 3 回国際身体活動公衆衛生会議（3rd International Congress of Physical Activity and Public Health; ICPAPH）において，非感染性疾患の予防・管理のために，専門家によるコンセンサスが図られた身体活動促進に特化した指針として、「身体活動のトロント憲章：世界規模での行動の呼びかけ（以下，「トロント憲章」）」が採択された[3,4)]。現在までに約 3 年が経過したが，その間，20 か国語（アラビア語，チェコ語，オランダ語，フィンランド語，フランス語，ドイツ語，ギリシャ語，イタリア語，日本語，ノルウェー語，ペルシャ語，ポーランド語，ポルトガル語，ブラジルポルトガル語，ロシア語，スペイン語，カス

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ティリヤ語，カタルーニャ語，タイ語，トルコ語）の翻訳版が公開され，英語版を併せて延べ 2,000 名以上により web ページからダウンロードされている。また，2013 年 1 月 1 日現在，126 か国における 825 名の個人および 249 の組織により「トロント憲章」への支持が表明されており，世界規模で支援（アドボカシー）活動が進められている [3]。

この「トロント憲章」を受ける形で，2011 年 2 月に「非感染性疾患予防：身体活動への有効な投資」が公刊された。この資料は，非感染性疾患対策に有効な科学的根拠が確認された投資すべき 7 つの身体活動促進戦略を取り上げたものであり，多くの国々において国民全体に対して実行することを奨励している [5]。そのため，我が国の運動疫学や健康づくり分野の研究・実践に携わる関係者にとっても極めて有益な内容を含んでいると考えられる。

本稿では，第 4 回 ICPAPH（シドニー，オーストラリア）への出席者が中心となって作成した「非感染性疾患予防：身体活動への有効な投資」日本語版について，翻訳の手順や資料の内容に関して解説する。また，日本語版および原（英語）版の資料を付表として添付した（付表 1 および 2）。

2．翻訳の手順

翻訳は，はじめに運動疫学を専門とする 8 名の研究者が各セクションの翻訳を担当し，その後，翻訳チームのコアメンバーによって内容確認および意見交換を行い，1 つの翻訳案に統合した。「トロント憲章」翻訳の際と同様に，翻訳案の作成にあたり，原本作成関係者と連絡を取り，内容の確認を行った。更に，運動疫学に関連した研究会等において関係者から広く意見を求めて翻訳内容を改訂し，最終版を確定した。

3．資料の内容

本資料では，非感染性疾患の予防・管理のために，世界中で応用することが可能な投資すべき 7 つの身体活動促進戦略が提案されている。それらは，1）「学校ぐるみ」のプログラム，2）歩行，自転車，公共交通の利用を優先する交通政策・システム，3）余暇身体活動，レクリエーションおよび移動に伴う歩行・自転車利用を，生涯にわたって公平かつ安全に行えるような機会を提供するための都市計画に関する規制およびインフラ，4）プライマリ・ヘルスケアシステムへの身体活動および非感染性疾患予防の統合，5）身体活動に関する意識を高め，社会規範を変えるためのマスメディア活用を含む一般社会に向けた教育，6）多数の場面や機関を巻き込み，地域の積極的な関与と資源の動員・統合による地域社会全体でのプログラム，7）「スポーツ・フォー・オール」を奨励し，生涯にわたる参加を促すスポーツシステムとスポーツプログラムの 7 つである。具体的には，セクションごとにエビデンスが確認された効果的な戦略と，それを実行する際に参考にすべき成功例などの情報源が紹介されている。以下，7 つの戦略それぞれについて概説する。

3-1.「学校ぐるみ」のプログラム

多くの子ども・青少年の身体活動促進のために，学校場面を活用したアプローチの重要性が示唆されている。有効な戦略として，教職員，保護者および地域をうまく巻き込み，①高強度の身体活動を実施する定期的な体育授業，②一日を通じた日常身体活動（例えば，学校に行く前，学校にいる間，放課後の遊びやレクリエーション）を支援する物理的環境の整備や資源の確保，③徒歩・自転車通学プログラムの実施が奨励されている。

3-2. 歩行，自転車，公共交通の利用を優先する交通政策・システム

身体活動を日常的に高める最も実用的で持続可能な手段として，大気汚染の改善や渋滞緩和，CO_2 排出量の削減といった副次的な便益も得られる「身体活動を伴う移動手段」の推進に焦点を当てている。具体的な戦略としては，歩道，自転車道，公共交通へのアクセスを高めるような土地利用方法に関する施策を立案すると同時に，歩行，自転車利用，公共交通（電車，路面電車，バスなど）の利用を推進する効果的なプログラムを組み合わせて実施することを強調している。

3-3. 余暇身体活動，レクリエーションおよび移動に伴う歩行・自転車利用を，生涯にわたって公平かつ安全に行えるような機会を提供するための都市計画に関する規制およびインフラ

このセクションでも，身体活動を伴う移動（徒歩や自転車の利用）や活動的なレクリエーションを後押しするために，歩道，自転車道，公共交通

機関といった交通網の整備に言及している。また，国や地方自治体の都市計画規制により，店，サービス，職場が住宅の近くにあるような混合型の土地利用規制や，徒歩や自転車で目的地まで移動しやすくなるような接続のよい道路網の整備を奨励している。更に，レクリエーション施設を備えた公共のオープンスペースや緑地の整備の必要性についても述べている。

3-4. プライマリ・ヘルスケアシステムへの身体活動および非感染性疾患予防の統合

身体活動の促進における医師および保健医療職の果たす役割は極めて大きい。そのため，保健医療システムの中で，非感染性疾患予防や患者教育のために通常行われている行動面の危険因子に関するスクリーニングに身体活動を含める必要がある。また，行動変容のための実用的かつ簡潔な助言や地域社会を基盤としたさまざまな支援と連携していくことが重要である。更に，危険因子となる行動の修正と身体活動を通じた非感染性疾患予防の能力を高めるための保健医療職に対するトレーニングの必要性が示唆されている。

3-5. 身体活動に関する意識を高め，社会規範を変えるためのマスメディアの活用を含む一般社会に向けた教育

本セクションでは、特に身体活動推進に果たすマスメディアの役割に言及している。人々の身体活動に対する意識を高め，知識を増やし，社会規範や価値観を変え，動機づけを高めるために，メディアを有効活用することを奨励している。具体的には，印刷媒体や広報，屋外看板やポスター，メッセージ標識，大規模参加型イベント，メールでのメッセージ配信やソーシャルネットワークなどを活用した情報の提供や共有である。また，地域の人々やイベントをうまく組み合わせたアプローチの必要性にも触れている。

3-6. 多数の場面や機関を巻き込み，地域の積極的な関与と資源の動員・統合による地域社会全体でのプログラム

人々が生活したり，働いたり，余暇を過ごす場において，生涯を通じた身体活動に対する「地域ぐるみ」での取り組みを実施することにより，集団レベルでの身体活動量を高めることを推奨している。そのために，都市や自治体，学校，職場などを有機的に機能させるとともに，身体活動促進を目的とした政策やプログラム，更には一般社会に向けた教育を一体的に進めることの重要性が示唆されている。

3-7. 「スポーツ・フォー・オール」を奨励し，生涯にわたる参加を促すスポーツシステムとスポーツプログラム

最後のセクションでは，「スポーツ・フォー・オール」の理念に基づいて，さまざまなスポーツ関係機関の協力の下，性・年齢・階層などの違いを越えたあらゆる人々の興味に応じた楽しいスポーツ活動を提供することの必要性に言及している。また，スポーツ産業やフィットネス産業の更なる発展や，スポーツのスター選手に役割モデルとしての機能を果たすことへの期待が述べられている。さまざまな支援策やプログラムにより，スポーツ参加への社会的，金銭的な障害を減らし，障害を持つ人々も含めて，身体活動への動機づけを高める必要性が示されている。

4．まとめ

本資料では，国民全体に対する身体活動促進対策が，経済水準が比較的高い先進国のみならず，急激な社会変革や経済変化が起こっている開発途上国においても必要とされており，世界規模で身体不活動の改善に取り組むことの重要性が指摘されている。特に，社会環境の整備の視点が強調されており，我が国における「健康日本21(第2次)」の身体活動・運動の目標の実現に向けても，本資料の内容は大いに役立てることができる。「トロント憲章」同様に，この資料がさまざまな場面で広く活用されることを期待している。

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【Practice Article】

Introduction of the "NON COMMUNICABLE DISEASE PREVENTION: Investments that Work for Physical Activity" Japanese version

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Abstract

"NON COMMUNICABLE DISEASE PREVENTION: Investments that Work for Physical Activity" was published as a complementary document of the "Toronto Charter for Physical Activity: A Global Call for Action (May, 2010)" in February, 2011. The document was also suggested by the Global Advocacy Council for Physical Activity and leading academics in the International Society of Physical Activity and Health. The authors participating in the 4th International Congress of Physical Activity and Public Health (Sydney, Australia in October-November, 2012) translated the document into Japanese. Related information, background, procedure of translation, and contents of the document were introduced in this article.

In this new document, 7 best investments for physical activity promotion which are supported by good evidence of effectiveness and that have worldwide applicability were suggested: 1) 'Whole-of-school' programs, 2) Transport policies and systems that prioritise walking, cycling and public transport, 3) Urban design regulations and infrastructure that provide for equitable and safe access for recreational physical activity, and recreational and transport-related walking and cycling across the life course, 4) Physical activity and NCD (non communicable disease) prevention integrated into primary health care systems, 5) Public education, including mass media to raise awareness and change social norms on physical activity, 6) Community-wide programs involving multiple settings and sectors and that mobilize and integrate community engagement and resources, and 7) Sports systems and programs that promote 'sport for all' and encourage participation across the life span. To reduce the burden of NCD and contribute to improving the quality of life (QOL) and the living environments, it is emphasized that these 7 investments for physical activity promotion should be implemented in many countries with adequate resources and at a population level. The Japanese and original (English) version are attached as the Appendix. We expect this new document to be used in various ways as well as the 'Toronto Charter'.

Key words: non communicable disease, investment, physical activity promotion, Toronto Charter

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【付表 1】

非感染性疾患予防—身体活動への有効な投資—

「身体活動のトロント憲章—世界規模での行動の呼びかけ—」の補足資料

身体不活動は、心疾患、脳卒中、糖尿病、がんなどの世界規模で蔓延する非感染性疾患による死亡原因の第 4 位であり、全世界で毎年 300 万人以上の予防可能な命が奪われている[1]。身体不活動は、高血圧、高コレステロール、高血糖のような非感染性疾患の主要な危険因子とも（直接的および間接的に）関連している。近年、先進国のみならず多くの開発途上国でも、子どもおよび成人において肥満者が急激に増加している。偏った食生活、喫煙および不適切な飲酒と同様に、身体不活動が非感染性疾患の危険因子の１つとして重要であることを十分な科学的根拠が支持している。

身体活動は生涯を通じた包括的な健康効果をもたらす—子どもや若年者においては健全な発育発達を促し、不健康な中年期には体重増加を防ぎ、高齢者においては健康的に年を重ね、生活の質（QOL）および自立を維持・向上させるのに重要である。

世界人口の 60%が不活動による健康リスクにさらされていることが、最近の世界的な調査で示されている[2]。国民全体の身体活動への参加を増やすことは、ほとんどの中・高所得国における健康施策の重要度の高い優先課題であり、急激な社会変化および経済変化を経験している低所得国においても急速に高まりつつある優先課題である。

「身体活動のトロント憲章」（2010 年 5 月）は、身体活動水準を高める政策やプログラムに投資することによる直接的な健康効果および副次的な効果について概要をまとめている[3]。「トロント憲章」は、すでに 11 種類の言語に翻訳されており、非感染性疾患予防に対する包括的なアプローチの一環として、身体活動に関する行動を増やし、より多くの投資をするよう強く主張している。憲章は、世界中の関係者（ステークホルダー）による広範な協議によって作成され、1）国家政策、2）政策および法令、3）プログラムおよび環境、4）協働という WHO の「Global Strategy for Diet and Physical Activity」とも一致する 4 つの鍵となる領域における行動を呼びかけている。

身体活動を増加させるための効果的なアプローチの推進を支持する強い証拠がある[4,5,6]。身体活動の減少傾向を食い止めるためには、身体不活動に関する個人的、社会文化的、環境的および政策的な決定要因に狙いを定めた戦略を組み合わせることに各国が積極的に取り組むことが求められると考えられる。身体活動は、政策および教育実践、交通、公園およびレクリエーション、メディア、ビジネスの影響を受けるため、社会の多様な部門がその問題解決に向けて関与する必要がある。安全で、利用しやすく、楽しめる方法で、個人および地域社会が活動的になるよう情報提供し、動機づけ、支援する明らかなニーズがある。***身体活動を増加させる単一の解決策はなく、効果的で包括的なアプローチには同時に複数の対策を行うことが求められるだろう。***すでに準備ができている国々を支援するために、身体活動のための７つの『最良の投資』があり、それらの有効性は優れた証拠によって裏付けられており、世界中で応用可能である。

1 「学校ぐるみ」のプログラム

学校は大多数の子どもに身体活動を提供でき、学童が生涯にわたって健康的で、活動的な生活を送るための知識、技能や習慣を習得することを援助するための重要な場（セッティング）の１つである。身体活動に関する「学校ぐるみ」のアプローチには、定期的で高強度の体育授業、1 日を通した身体活動（たとえば、学校に行く前、学校にいる間そして放課後の遊びやレクリエーション）を支援する物理的環境および資源の提供、徒歩・自転車通学プログラムの支援を優先するとともに、支援的な学校方針や教職員、学童、保護者および地域を通じて、これらすべての対策を可能にすることが含まれる。身体活動に関する学校ぐるみのアプローチを実施するための最良の方法に関する詳細な情報は、以下から入手できる：