BMJ Open

Sarcopenia and coexistent risk factors detected using the 'Yubi-wakka' (finger-ring) test in adults aged over 65 years in the public annual health check-up in Tama City, Tokyo: a cross-sectional study

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To cite: Fujii H, Kodani E, Kaneko T, *et al*. Sarcopenia and coexistent risk factors detected using the 'Yubi-wakka' (finger-ring) test in adults aged over 65 years in the public annual health check-up in Tama City, Tokyo: a cross-sectional study. *BMJ Open* 2022;**12**:e061613. doi:10.1136/bmjopen-2022-061613

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-061613).

Received 05 February 2022
Accepted 13 December 2022

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ABSTRACT

Objectives To examine the positive rate of sarcopenia using the 'Yubi-wakka' (finger-ring) test and associated risk factors among adults aged 65 years and older.

Design Cross-sectional study.

Setting We used the Yubi-wakka test, which has been developed and validated as a predictor of sarcopenia, frailty, disability and mortality. A positive test result is indicated by a smaller calf circumference than the finger-ring. The test was administered during annual health check-ups among residents of Tama City, Japan.

Participants During the 2019 fiscal year, 12 894 individuals aged 65 years and older underwent the Yubi-wakka test at primary care clinics.

Interventions Examinees conducted the test themselves in a seated position. They formed a ring around their calf using both thumbs and index fingers and judged whether their calf was larger, the same or smaller than their finger-ring.

Primary and secondary outcome measures We compared anthropometric and serological data between the positive (smaller calf) and negative (larger calf) test result groups.

Results The positive rate was 15.4% among men and 18.5% among women. The prevalence of a positive result was higher in those aged ≥80 years than in younger age groups in both sexes (men: 22.8%; women: 28.8%). Multivariate logistic regression analysis showed that a diagnosis of metabolic syndrome was a risk factor for detecting a positive test result in women aged 65–74 years (OR 3.445; 95% CI 1.44 to 8.29) and ≥75 years (OR 3.37; 95% CI 1.97 to 5.78).

Conclusions Because the Japanese population is healthy and lives long, interventions against sarcopenia are important, especially for older adults aged >75 years. The presence of metabolic syndrome may be a risk factor for sarcopenia (as detected by the Yubi-wakka test) and future frailty, and requires closer attention, especially among women.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ We cross-sectionally analysed the prevalence of sarcopenia judged using the 'Yubi-wakka' (finger-ring) test during annual health check-ups in Japan among 12 894 individuals aged >64 years and 6649 individuals aged ≥75 years.
⇒ We included a large sample of the oldest examinees, first analysed using this Yubi-wakka test.
⇒ Because this was a cross-sectional study to identify factors related to sarcopenia, we did not identify causal relationships.
⇒ Although the Yubi-wakka test is a user-friendly tool, it cannot fully reflect a 'sarcopenic state'.

INTRODUCTION

The 'Yubi-wakka' (finger-ring) test was developed as a practical and cost-saving self-check method by Tanaka *et al*[1] and has been validated for its ability to identify the risk of future sarcopenia, disability and mortality.

In Tama City, a western suburb of Tokyo, the Tama City Medical Association (local physicians' association) began implementing the Yubi-wakka test during annual health check-ups in the 2017 fiscal year. We previously reported the results of the Yubi-wakka test conducted in annual health check-ups during the 2017 fiscal year.[2] The test was performed among individuals aged 65–74 years in a partial self-screening manner, and the results showed a relationship with other clinical data. From the 2019 fiscal year, we began using this test during health check-ups among people aged 75 years and older. However, no studies have validated the Yubi-wakka test for predicting future frailty and the presence of frailty among people aged ≥75 years.

In this study, we aimed to examine the positive rate of the Yubi-wakka test as a surrogate

marker for the prevalence of sarcopenia and identify associated factors, such as metabolic syndrome (MetS), in older populations. We hypothesised that the rate of test-positive people would be higher in those of older age (≥75 years), and MetS may be positively related to the test results.

MATERIALS AND METHODS

Study of Tama City Medical Association (TAMA MED) Project Frail

The TAMA MED Projects (Project Atrial Fibrillation,[3–5] Chronic Kidney Disease[4–6] and Frail[2]) were conducted by the Tama City Medical Association to analyse consecutive annual health check-up data for national health insurance in Japan. All authors contributed to this work and agreed with the content of the present manuscript.

Patient and public involvement

No patients were involved in this study.

Participants

We selected annual check-up data for 12 894 health check-up examinees (5442 men and 7452 women) that included the Yubi-wakka test results for individuals aged ≥65 years in the 2019 fiscal year. The examinations were primarily performed at primary care clinics in the private sector. Primary care doctors were asked to perform the Yubi-wakka test, although the test was not mandatory.

'Yubi-wakka' (finger-ring) test

Detailed methods of this test have been explained elsewhere.[1] Briefly, while in a seated position, the examinee is asked to form a 'finger-ring' by joining both their thumbs and index fingers around their non-dominant calf. The examinee determined whether their calf was 'larger', 'the same' or 'smaller' than their finger-ring. If the calf circumference was judged as smaller than their finger-ring, the result was considered positive.

At the beginning of this study, a written request was sent to registered local practitioners to participate in this study. The request provided an explanation with pictures of how to perform the test. We selected participants who had 'smaller' and 'larger' calf circumferences (ie, positive and negative test result groups) and excluded the group with the 'same' measurement when analysing correlated factors.

National insurance annual check-up in Tama City

Anthropometric data, including body height (BH), body weight (BW), waist circumference (WC) and blood pressure (BP), were measured during the annual check-ups. We evaluated MetS, which was defined using the Japanese criteria: WC at the umbilical level (men: ≥85 cm, women: ≥90 cm) and two or more of the following factors: (1) elevated triglyceride (TG) level (≥150 mg/dL) or reduced high-density lipoprotein cholesterol (HDL-C; ≤40 mg/dL), (2) elevated systolic BP (≥130 mm Hg) or diastolic BP (≥85 mm Hg), or (3) elevated fasting plasma glucose (FPG; ≥110 mg/dL) level. Serum and urine samples were obtained to test serum albumin, liver enzymes, amylase, creatinine (Cr), creatine kinase (CK), uric acid (UA), lipids, glucose, glycosylated haemoglobin (HbA1c) and blood cell counts, and responses to simple medical history questions were recorded.

The health check-ups were conducted independently by different municipal organisations. For residents aged under 75 years, check-ups were conducted by Tama City, and for those aged 75 years and older, they were conducted by Tokyo Metropolitan National Health Insurance Organization. The present study was the first to collect data across all older age groups (ie, groups aged 65–74 years and ≥75 years).

Statistical analysis

We compared the distribution of test results between age and sex groups using X^2 tests. We also compared anthropological and serum data according to the Yubi-wakka test results (ie, positive and negative groups) using Student's t-tests. We used logistic regression to adjust for multiple variables and identify predictors of a positive Yubi-wakka test result. All variables were entered simultaneously to identify potential risk factors and adjust background factors, such as sex, age, BH and BW. To avoid collinearity, we included BW and BH instead of body mass index (BMI), and excluded WC in favour of MetS. Statistical analyses were performed using IBM SPSS V.23.0 (IBM Corp).

RESULTS

We obtained data for 12 894 health check-up examinees (5442 men and 7452 women) aged 65 years and older. A total of 840 men (15.4%) and 1379 women (18.5%) had a positive Yubi-wakka test result, and 2233 men (41.0%) and 2973 women (39.9%) had a negative Yubi-wakka test result (table 1). We compared the rate of positive Yubi-wakka tests among those aged over 65 years, grouped in 5-year intervals. The group aged 80–84 years had a significantly different distribution from that of age groups younger than 79 years in both sexes (table 1 and figure 1).

We compared the characteristics of the positive (smaller) group with the negative (larger) group (tables 2 and 3) according to sex and age groups (65–74 years and ≥75 years). BMI was significantly lower in the positive group than in the negative group. BP and the prevalence of MetS were lower in the positive group than in the negative group. The smoking rate was significantly lower in the group aged ≥75 years than in those aged 65–74 years. The medication rates for hyperlipidaemia, hypertension and diabetes were lower in the positive group than in the negative group; however, the medication rate for diabetes did not significantly differ among men (table 2).

Comparison of serological data showed HbA1c was lower in the positive group than in the negative group except among men aged ≥75 years (table 3). All groups with a positive Yubi-wakka test result tended to have lower

Table 1 Distribution of results of the 'Yubi-wakka' (finger-ring) test

Age group, years	Men (n, %)*			
	Larger	Same	Smaller	Total*
65–69	484 (48.3)	394 (39.3)	125 (12.5)	1003 (100, 18.4)
70–74	701 (44.2)	693 (43.7)	193 (12.2)	1587 (100, 29.2)
75–79	568 (40.3)	650 (46.1)	193 (13.7)	1411 (100, 25.9)
80–84	315 (35.4)	388 (43.5)	188 (21.1)	891 (100, 16.4)
85–89	132 (29.4)	209 (46.5)	108 (24.1)	449 (100, 8.25)
≥90	33 (32.7)	35 (34.7)	33 (32.7)	101 (100, 1.86)
Total	2233 (41.0)	2369 (43.5)	840 (15.4)	5442 (100, 100)
	Women (n, %)*			
65–69	674 (44.3)	644 (42.3)	204 (13.4)	1522 (100, 20.4)
70–74	921 (43.2)	920 (43.1)	292 (13.7)	2133 (100, 28.6)
75–79	769 (41.8)	750 (40.8)	319 (17.4)	1838 (100, 24.7)
80–84	374 (33.8)	469 (42.3)	365 (23.9)	1208 (100, 16.2)
85–89	177 (31.8)	239 (42.9)	141 (25.3)	557 (100, 7.47)
≥90	58 (29.9)	78 (40.2)	58 (29.9)	194 (100, 2.60)
Total	2973 (39.9)	3100 (42.2)	1379 (18.5)	7452 (100, 100)

The null hypothesis for the equal distribution of the results among age groups was rejected (X^2 test).
*P<0.001 in both men and women.

haemoglobin (Hb), except for women aged 65–74 years. HDL-C was higher in the positive group than in the negative group, and low-density lipoprotein cholesterol (LDL-C) in men and TG level (except in men aged ≥75 years) were lower in the positive group than in the negative group. Cr clearance in all age groups, Cr in those aged 65–74 years and CK in all groups (except women aged 65–74 years) were lower in the positive group than in the negative group. The estimated glomerular filtration rate (eGFR) was a predictive factor for a positive Yubi-wakka test result in all age groups. Among men, albumin was lower in the positive group than in the negative group. Alanine transaminase and UA were lower in the positive group than in the negative group. Alkaline phosphatase in men and amylase in all groups were higher in the positive group than in the negative group.

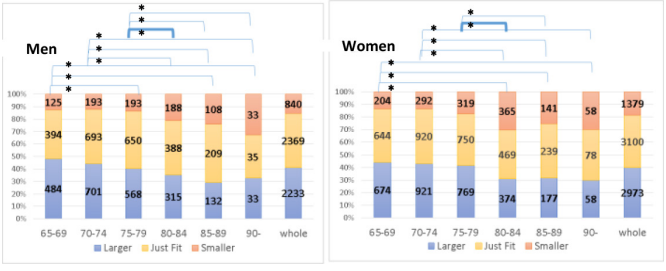

Figure 1 Distribution of Yubi-wakka test results by age group and sex. Comparisons between age groups were analysed using X^2 tests and the Kruskal-Wallis tests. Square brackets indicate that the null hypothesis was rejected between the distributions of the two age groups. *P<0.05.

We conducted multivariate logistic regression tests (table 4) by simultaneously entering all variables. We included BH, BW and MetS, but excluded WC and BMI. A moderate attributable rate (R^2) of approximately 0.5 was obtained. BH and BW were independent predictive factors for a test result, although the direction was opposite. Higher BH and lower BW were positively related to a positive test result (smaller calf than the finger-ring). Age was a positive factor for people aged ≥75 years. MetS among women and pre-MetS among men aged ≥75 years were positive factors for positive test results. Higher eGFR among women was a positive factor. Lower CK but higher Cr were positive factors in women aged ≥75 years. However, the CI for Cr was wide (1.15 to 85.05). In the women aged 65–74 years, smoking, Hb, aspartate transaminase (AST) and LDL-C were positively related to a smaller calf than the finger-ring. Hb was also a positive factor among men aged ≥75 years. Higher HbA1c was a negative factor among men aged 65–74 years and women aged ≥75 years. Among men aged ≥75 years, HDL was a negative factor against positive test result.

DISCUSSION

In the present study, the positive (smaller calf than finger-ring) rate of the Yubi-wakka test in those aged over 75 years was over 20%, which was considerably higher than the 12%–14% reported among those aged 65–74 years in previous studies.[1 2] The positive rate in the group aged 80–84 years was significantly higher than in those aged 75–79 years. This indicated that there was a cut-off point

Table 2 Comparison of physical and medication data between the larger and smaller groups based on the 'Yubi-wakka' (finger-ring) test

	Men					Women				
	Larger (n=1185)		Smaller (n=318)			Larger (n=1595)		Smaller (n=486)		
Age 65–74 years	**Mean**	**SD**	**Mean**	**SD**	**P value**	**Mean**	**SD**	**Mean**	**SD**	**P value**
Age (years)	70.0	2.5	70.0	2.6	0.981	70.0	2.6	69.9	2.6	0.764
Body mass index (kg/m^2)	**24.8**	2.8	21.0	2.7	< 0.001	**24.0**	3.4	19.4	2.5	<0.001
SBP (mm Hg)	130.9	15.1	129.0	18.9	0.090	**130.4**	16.7	127.3	17.2	<0.001
DBP (mm Hg)	76.8	10.1	75.7	12.1	0.118	75.0	10.3	74.2	11.3	0.157
MetS (%)	**40.8**		14.8		<0.001	**16.7**		2.8		<0.001
Pre-MetS (%)	**22.4**		10.4			**10.5**		1.0		
Non-MetS (%)	36.8		**74.5**			72.7		**95.2**		
Smoker (%)	17.6		**25.8**		0.001	3.8		**10.1**		<0.001
Med (HL) (%)	**29.2**		18.2		<0.001	**35.2**		20.2		<0.001
Med (HT) (%)	**51.8**		37.1		<0.001	**39.7**		24.0		<0.001
Med (DM) (%)	16.5		12.3		0.068	**10.3**		5.0		<0.001
	Larger (n=1048)		**Smaller (n=522)**			**Larger (n=1378)**		**Smaller (n=783)**		
Age 75 years or more	**Mean**	**SD**	**Mean**	**SD**	**P value**	**Mean**	**SD**	**Mean**	**SD**	**P value**
Age (years)	80.0	4.3	**81.6**	4.7	<0.001	80.0	4.5	**81.5**	4.9	<0.001
Body mass index (kg/m^2)	**25.0**	2.8	20.7	2.7	<0.001	**24.6**	3.4	19.7	2.7	<0.001
SBP (mm Hg)	**132.7**	16.0	130.6	18.2	0.027	133.5	16.1	132.2	17.2	0.084
DBP (mm Hg)	**72.9**	10.9	71.5	10.7	0.018	**72.2**	10.5	70.6	10.7	<0.001
MetS (%)	**46.9**		17.0		<0.001	**25.6**		5.7		<0.001
Pre-MetS (%)	**23.0**		10.3			**12.6**		3.1		
Non-MetS (%)	29.8		**70.5**			61.6		**88.8**		
Smoker (%)	8.9		11.7		0.087	1.6		2.2		0.401
Med (HL) (%)	**30.5**		23.9		0.006	**42.5**		32.8		<0.001
Med (HT) (%)	**61.1**		54.2		0.011	**60.0**		46.1		<0.001
Med (DM) (%)	18.6		16.7		0.365	**11.8**		7.8		0.003

Analysed using Student's t-tests and X^2 tests. Significantly higher values are in bold.
MetS was defined using Japanese criteria: waist circumference at the umbilical level (men: ≥85 cm, women: ≥90 cm) plus two or more of the following: (1) elevated triglyceride level (≥150 mg/dL) or reduced high-density lipoprotein cholesterol (≤40 mg/dL), (2) elevated SBP (≥130 mm Hg) or DBP (≥85 mm Hg), (3) elevated fasting plasma glucose ≥110 mg/dL.
DBP, diastolic blood pressure; DM, diabetes mellitus; HL, hyperlipidaemia; HT, hypertension; Med, medication; MetS, metabolic syndrome; SBP, systolic blood pressure.

between age 75 and 84 years in both sexes. The positive group tended to have lower BMI, Cr, albumin and Hb in the univariate analysis. These tendencies suggested that this test could detect sarcopenic features of the positive (smaller calf) group. However, the multivariate analysis showed that MetS was an independent predictive factor for a positive Yubi-wakka test result, especially among women.

Distribution of results of the Yubi-wakka test

The cut-off age as the reflection point of the distribution of sarcopenia defined using our Yubi-wakka test was about 80 years. The objective of health check-ups for individuals aged under 75 years in Japan is to detect and intervene in MetS and prevent future cardiovascular and other atherosclerotic events. For individuals older than 75 years, the main objective of health check-ups is to prevent or intervene in frailty. Our study findings support the rationale behind the Japanese Ministry of Health, Labour and Welfare dividing the check-up system by age group.

Evaluating sarcopenic obesity and MetS as predictive factors of sarcopenia

Although the Yubi-wakka test has some limitations, a positive result is considered to indicate a tendency toward sarcopenia. Our multiple regression analysis showed that BW was negatively related to sarcopenia in all groups. HbA1c was also a protective factor against sarcopenia in men aged 65–74 years and women aged ≥75 years. Most people with diabetes who undergo annual health check-ups are followed regularly at clinics for their diet, exercise and pharmacotherapy. Therefore, even

Table 3 Comparison of serological data between the larger and smaller groups based on the 'Yubi-wakka' (finger-ring) test

	Men					Women				
	Larger (n=1185)		Smaller (n=318)			Larger (n=1595)		Smaller (n=486)		
Age 65–74 years	Mean	SD	Mean	SD	P value	Mean	SD	Mean	SD	P value
HbA1c (%)	**5.9**	0.8	5.7	0.7	<0.001	**5.8**	0.6	5.6	0.5	<0.001
Hb (g/dL)	**14.8**	1.2	14.4	1.3	<0.001	13.4	1.0	13.4	1.1	0.229
HDL-C (mg/dL)	56.6	14.4	**64.5**	17.5	<0.001	66.5	14.1	**74.6**	16.8	<0.001
LDL-C (mg/dL)	**121.1**	30.4	116.9	30.0	0.028	131.3	29.8	134.2	32.5	0.067
TG (mg/dL)	**131.4**	83.7	116.2	75.1	0.003	**112.6**	59.7	102.7	85.4	0.004
Cr (mg/dL)	**0.9**	0.2	0.9	0.3	0.004	**0.7**	0.2	0.6	0.2	0.011
eGFR (mL/min/1.73 m^2)	67.4	13.4	**71.3**	14.7	<0.001	70.1	13.8	**73.9**	15.4	<0.001
CCr (mL/min)	**77.5**	17.1	69.4	15.4	<0.001	**73.2**	17.2	63.2	15.3	<0.001
CK (mg/dL)	**141.3**	109.8	120.0	88.3	<0.001	111.2	65.7	114.9	190.5	0.671
ALB (mg/dL)	**4.3**	0.3	4.3	0.3	0.032	4.3	0.2	4.3	0.2	0.256
AST (IU/L)	25.6	10.4	25.0	12.3	0.396	24.4	9.2	25.0	11.9	0.208
ALT (IU/L)	**24.5**	14.3	20.6	11.3	<0.001	**20.9**	12.0	19.2	20.7	0.019
ALP (mg/dL)	210.9	61.2	**226.2**	77.8	0.001	229.3	86.6	227.7	79.1	0.721
AMY (mg/dL)	85.4	41.4	**91.1**	35.2	0.026	82.0	29.7	**88.8**	33.3	<0.001
UA (mg/dL)	**5.9**	1.2	5.8	1.2	0.029	**4.9**	1.1	4.5	1.1	<0.001
	Larger (n=1048)		Smaller (n=522)			Larger (n=1378)		Smaller (n=783)		
Age ≥75 years	Mean	SD	Mean	SD	P value	Mean	SD	Mean	SD	P value
HbA1c (%)	5.9	0.7	5.9	0.8	0.178	**5.8**	0.6	5.7	0.5	<0.001
Hb (g/dL)	**14.2**	1.4	13.6	1.5	<0.001	**13.1**	1.2	12.7	1.2	<0.001
HDL-C (mg/dL)	55.1	14.1	**59.6**	15.6	<0.001	64.1	15.2	**69.2**	16.7	<0.001
LDL-C (mg/dL)	**117.0**	28.2	110.7	27.7	<0.001	123.8	29.6	123.2	30.4	0.638
TG (mg/dL)	126.3	73.1	105.6	64.1	0.153	**113.0**	56.4	103.5	53.6	<0.001
Cr (mg/dL)	1.0	0.3	1.0	0.8	0.181	0.7	0.2	0.7	0.4	0.870
eGFR (mL/min/1.73 m^2)	61.7	14.3	**62.8**	17.1	0.001	63.0	13.8	**65.2**	16.1	0.002
CCr (mL/min)	**61.1**	15.9	50.3	14.5	0.001	**57.4**	15.1	47.0	13.5	< 0.001
CK (mg/dL)	**134.5**	104.4	116.4	91.1	0.006	**110.1**	74.5	100.0	58.2	0.001
ALB (mg/dL)	**4.2**	0.3	4.1	0.3	<0.001	4.2	1.8	4.2	0.3	0.342
AST (IU/L)	**26.3**	11.8	24.7	10.5	0.034	24.4	9.3	24.7	10.3	0.563
ALT (IU/L)	**22.4**	12.4	18.3	10.6	<0.001	**18.7**	12.9	16.9	11.5	0.002
ALP (mg/dL)	215.9	64.2	**236.9**	98.5	<0.001	229.5	76.8	230.0	84.3	0.888
AMY (mg/dL)	89.6	23.8	**101.3**	35.5	<0.001	83.8	33.8	**99.0**	46.9	<0.001
UA (mg/dL)	**5.9**	1.2	5.6	1.3	<0.001	**5.1**	1.1	4.8	1.3	<0.001

Analysed using Student's t-tests. Significantly higher values (p<0.05) are in bold.

ALB, albumin; ALP, alkaline phosphatase; ALT, alanine transaminase; AMY, amylase; AST, aspartate transaminase; CCr, creatinine clearance; CK, creatine kinase; Cr, creatinine; eGFR, estimated glomerular filtration rate; Hb, haemoglobin; HbA1c, glycosylated haemoglobin; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride; UA, uric acid.

those with a long history of diabetes are unlikely to have sarcopenia.

A lack of oestrogen is considered to contribute to the storage of fat tissue in the abdomen in older women.[7] The Japanese definition of MetS comprises a large WC (men/women ≥85/90 cm) and other metabolic conditions, such as hypertension, triglyceridaemia and impaired glucose tolerance. We found that a MetS diagnosis (in all women and men aged ≥75 years), a higher BH and a lower BW were independent predictive factors for a positive Yubi-wakka test result (table 4). MetS among women aged 65 years and older has been reported to be correlated with visceral obesity and other atherosclerotic risk factors, and negatively correlated with appendicular muscle mass,[8]

Table 4 Multivariate logistic regression models (positive 'Yubi-wakka' (finger-ring) test result or smaller calf than the finger-ring) (forced entry method)

65–74 years old							
Men (R^2=0.471, n=1106)				**Women (R^2=0.547, n=1548)**			
	OR	**CI**	**P value**		**OR**	**CI**	**P value**
BH	**1.235**	**1.180 to 1.293**	**<0.001**	**MetS**	**3.445**	**1.436 to 8.285**	**0.006**
FPG	1.026	1.013 to 1.038	<0.001	*Non-MetS*	*Ref*		
				Smoking	2.657	1.356 to 5.207	0.004
				Hb	1.311	1.089 to 1.579	0.004
				BH	**1.264**	**1.215 to 1.315**	**<0.001**
				eGFR	*1.043*	*1.017 to 1.070*	*0.001*
				AST	1.039	1.005 to 1.074	0.024
				LDL-C	1.012	1.006 to 1.018	<0.001
BW	**0.775**	**0.741 to 0.811**	**<0.001**				
HbA1c	0.398	0.248 to 0.639	<0.001	**BW**	**0.732**	**0.704 to 0.762**	<0.001
Older than 74 years old							
Men (R^2=0.546, n=1163)				**Women (R^2=0.574, n=1641)**			
MetS	*1.369*	*0.803 to 2.306*	*0.252*	Cr	9.894	1.151 to 85.054	0.037
Pre-MetS	**1.85**	**1.075 to 3.183**	**0.026**	**MetS**	**3.366**	**1.961 to 5.778**	**<0.001**
Non-MetS	*Ref*			**Pre-MetS**	**3.421**	**1.731 to 6.762**	**<0.001**
BH	**1.231**	**1.183 to 1.282**	**<0.001**	*Non-MetS*	*Ref*		
Hb	1.176	1.007 to 1.375	0.041	**BH**	**1.243**	**1.202 to 1.285**	**<0.001**
Age	*1.076*	*1.030 to 1.123*	*<0.001*	*Age*	*1.095*	*1.055 to 1.136*	<0.001
				eGFR	*1.032*	*1.006 to 1.059*	*0.016*
				CK	0.996	0.993 to 0.999	0.003
HDL	0.986	0.973 to 0.999	0.040	**BW**	**0.722**	**0.696 to 0.749**	**<0.001**
BW	**0.711**	**0.671 to 0.754**	**<0.001**	HbA1c	0.638	0.428 to 0.951	0.027

All variables were entered: age, BH, body weight, HbA1c, FPG, Hb, HDL cholesterol, LDL-C, triglyceride, eGFR, AST, alanine transaminase, gamma-glutamyl transpeptidase, albumin, alkaline phosphatase, Cr, CK, MetS, pre-MetS, non-MetS (reference=0), systolic blood pressure, diastolic blood pressure, uric acid, iron, urinary protein, present and past smoking status, abnormal ECG, medication for hypertension, medication for diabetes, medication for dyslipidaemia.
Urinary glucose and Cr clearance and body mass index were excluded.
Only statistically significant variables are shown in the table.
AST, aspartate transaminase; BH, body height; CK, creatine kinase; Cr, creatinine; eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; Hb, haemoglobin; HbA1c, glycosylated haemoglobin; HDL, high-density lipoprotein; LDL-C, low-density lipoprotein cholesterol; MetS, metabolic syndrome.

which may be associated with sarcopenia, especially sarcopenic obesity.[7] We also found that having MetS was positively correlated with smaller calves, especially among women. Our results provide supporting evidence that MetS with visceral obesity may be correlated with sarcopenic obesity.[8]

Other factors related to a positive Yubi-wakka test result

Both higher HDL-C (in men) and CK levels (in women) were correlated with physical activity and muscle mass and were shown to be protective factors against smaller calves in the multivariate analysis among adults aged 75 years and older. Moreover, higher FPG (in men aged 65–74 years) is speculated to be related to lower basal insulin secretion or possibly excessive alcohol intake, which makes elevated morning glucose positively correlated with sarcopenia among men. AST (in women aged 65–74 years) was previously reported[9] to be directly related to skeletal muscle mass. Cr (in women aged ≥75 years), which had wide CIs, and eGFR (among women) were risk factors for a positive Yubi-wakka test result. Although we included limited participants with chronic renal failure, their Cr values were extremely high, which may have influenced the low muscle mass results. However, among those who did not have renal failure, a high eGFR was considered to be related to low Cr and muscle mass.

Although smoking (in women aged 65–74 years) was an expected risk factor for a positive Yubi-wakka test result, the smoking population among women was relatively

small (<10%) in those aged 65–74 years, and much small in those aged ≥75 years (table 2). Hb (in women aged 65–74 years and men aged ≥75 years) as a positive factor for a positive test result appeared paradoxical. Although the reason was unclear, this phenomenon was also observed among these groups in our previous study[2] and may be related to drug-induced or smoking-induced haemo-concentrated condition or polycythaemia (eg, by smoking, sodium/glucose cotransporter 2 inhibitors and diuretics). These factors are likely to coexist with sarcopenia. In this study, the population of smokers among women aged ≥75 years was too small to show a significant difference.

Limitations

Participant characteristics

Participants who undergo annual check-ups are generally healthier and more health conscious than those who do not undergo check-ups. This means there is a possibility that the number of people with sarcopenia was underestimated. The Yubi-wakka test can be performed by individuals with minimal supervision; however, the supervision provided may vary between clinics,[2] which might have contributed to the distribution of test results and affected the discrimination of the 'just fit' group relative to the 'smaller' and 'larger' groups.

Limitations of detecting sarcopenia using the Yubi-wakka test

The Yubi-wakka test can only be used to evaluate the size of the calf but not the subcutaneous or intramuscular fat tissue or muscle strength. Recently, skeletal muscle mass (excluding fat tissue) has been measured using dual-emission X-ray absorptiometry,[10] although guidelines for frailty, both domestic[11] and international,[12] indicate that measuring muscle strength rather than muscle mass is preferable. Moreover, grip strength may serve as a substitute. However, our local doctors' association chose the Yubi-wakka test because of its convenience. Although we considered a positive Yubi-wakka test result as indicative of sarcopenia, this cannot be fully confirmed.

The Yubi-wakka test reflects sarcopenia and also physical size

We excluded factors with collinearity and used multivariate analysis to adjust for confounding factors; however, MetS includes WC in its diagnosis and correlates with physical size. It has already proven that taller people tended to have longer fingers and consequently larger finger-ring size,[1] which may have led to a positive Yubi-wakka test result. The intention of using examinees' own finger-ring (and not just measuring their calf circumference) is supposed to reflect adjustment of the test result by their own physical size. However, this sometimes appears to be overadjusted.

The reason for MetS being negatively correlated with the positive test result in our univariate analysis but becoming positive in the multivariate analysis may be the relatively large physical size with a greater finger-ring circumference. However, in the multivariate analysis, adjustment for participants' own physical size (BW and BH), visceral fat, and hypertension, triglyceridaemia and glucose intolerance may be a real positive factor for sarcopenia or a positive test result of the Yubi-wakka test. We considered this is an essential limitation of estimating sarcopenia using the quantity instead of the strength of the muscles.

Methodological limitations of this study

The data used in this study were cross-sectional. However, longitudinal datasets are needed to confirm our results. We excluded the 'same' group from the analysis, which improved the goodness of fit (R^2); however, this group may not be sufficiently discriminant from other groups. In addition, we were unable to use 40% of the participant data; therefore, our analysis may only reflect a comparison between sarcopenic and relatively obese individuals and not between individuals with sarcopenia and those without sarcopenia.

CONCLUSION

The Japan Geriatric Society has redefined the older adult population from those aged 65 years and older to those aged 75 years and older because of recent improvements in the health of older adults in Japan that equal that of individuals approximately 10 years younger. The present study suggested that the cut-off age for sarcopenia (judged using the Yubi-wakka test) was around 80 years. However, longitudinal studies are needed to confirm whether a positive Yubi-wakka test result and related factors are short-term indicators and predictors of frailty. Japan has the most ageing society in the world; however, this tendency of improved health among older individuals is likely to be observed worldwide. Although MetS is a predictor of atherosclerotic disease, it remains uncertain as a predictor of frailty. We found that among women, MetS was at least a factor related to sarcopenia, as defined by our Yubi-wakka test. Therefore, more attention should be paid to sarcopenic obesity, especially among women.

Acknowledgements We are grateful to all the participants who underwent health check-ups and provided consent to use their data. We thank members of the Tama City Medical Association for their cooperation. We thank Professor Katsuya Iijima, who developed the 'Yubi-wakka' test, for offering advice and permission to use the test. We thank Mr Junichi Murata for performing the statistical analysis. Finally, we thank Sarina Iwabuchi, from Edanz (https://jp.edanz.com/ac), for editing a draft of this manuscript.

Contributors HF performed the data collection and analysis and wrote the paper. HF is responsible for the overall content as guarantor. HF accepts full responsibility for the finished work and/or the conduct of the study, had access to the data, and controlled the decision to publish.HN, HS and YT performed the data collection and participated in discussions. EK and TK designed the study and provided expert clinical knowledge during critical revision. All authors approved the final version of the submitted manuscript.

Funding This work was supported by the Tama City Medical Association.

Disclaimer The sponsor had no role in the design and conduct of the study; the collection, analysis and interpretation of data; the preparation of the manuscript; or review or approval of the manuscript.

Competing interests EK received remuneration from Daiichi-Sankyo and Ono Pharmaceutical. All other authors have no conflicts of interest to declare.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval The present research was based on the results of the annual check-up for national health insurance in Tama City. Tama City included information on the application form for the check-up that their data may be anonymously analysed and published for public health research and that they have the right to opt out or refuse their consent. The same information was provided on the Tama City Medical Association website. Our study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). We obtained Institutional Review Board approval from the Tama Center Mirai Clinic (no. 2020013).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

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