"Yubi-wakka" (Finger-Ring) Test: A Tool to Detect Prefrailty in Elderly Populations, a Pilot Study

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Abstract

Background: Preventing frailty of elderly is an urgent issue in Japan. The "Yubi-wakka" (finger-ring) test was developed and validated as a predictor of sarcopenia, disability and even mortality. To clarify the prevalence of "frailty" defined by this test and the relationship between other indexes cross-sectionally and prospectively, we conducted this study.

Methods: Five thousand four hundred and five subjects who were 65 to 74 years old participated in this study. In a sitting position, the subjects surrounded their calf using their own finger-ring, and whether the calf was larger, just fit, or smaller than the finger-ring was determined. We analyzed these "Yubi-wakka" (finger-ring) test results and other clinical indexes. We used Student's t-tests and the Chi-squared tests to compare the data between the groups, and logistic regression tests to adjust for multiple variables.

Results: In total, 38.8% of the subjects' calves were judged as being "larger", 45.6% as "just fit" and 15.6% as "smaller", which was the positive test result. The positive rate differed among medical facilities without any known different characteristics. The comparison between the "larger" and "smaller" groups revealed that body weight, red blood cell count, serum lipids, uric acid and liver enzymes were significantly different between the groups. Metabolic syndrome was more common in the "larger" group. In multiple analysis, low body mass index was an independent risk factor in both sexes. Positive urinary glucose, higher aspartate aminotransferase, systolic blood pressure and low alanine transaminase were risk factors for positive test results for males. Smoking, high hemoglobin and old age were risk factors for positive test results in females.

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Conclusions: The test was simple and feasible enough for the primary care setting, without the requirement of any devices. However, the positive rate varied among the clinics. The subjects' age was limited to under 75 years, and the test possibly detected individuals without metabolic syndrome and fatty liver. We are also planning to increase the subjects' age range and collect data prospectively.

Introduction

In a rapidly aging society such as Japan, detecting the risk of frailty at an earlier stage, preventing its progression and prolonging independent healthy life is crucial. Local governments are trying to reduce these burdens through the implementation of lifestyle modifications and interventions. In Tama City, a western suburb of Tokyo, the doctors' association (TAMA CITY Medical Association) decided to participate in the study by implementing the "Yubi-wakka" (finger-ring) test along with the annual checkup in the 2017 fiscal year. The test needs to be validated to be feasible enough for primary care providers in ordinary practice and sensitive enough to detect current sarcopenia and the likelihood of frailty in the future.

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

Materials and Methods

Study design of TAMA MED project-frail

The TAMA MED projects (project atrial fibrillation [2], chronic kidney disease and frail) by the TAMA CITY Medical Association (local doctors' association) have been conducted to analyze the annual national insurance checkup data from consecutive years as a retrospective cohort study. Project-frail was just initiated by this pilot study, and prospective and financial studies are planned in the future. All authors have contributed significantly and that all authors are in agreement with the con-

tent of the manuscript.

Ethical consideration

Since our research is based on the results of the annual checkup of national insurance in Tama City, and Tama City and TAMA CITY Medical Association opted out as informed consent for examinees that this checkup data would be possibly used for the researches, anonymously analyzed and published, and they had the right to refuse. Our study was conducted in accordance with the Declaration of Helsinki (as revised in Brazil 2013). We obtained the IRB approval of Tama-Center Mirai Clinic and Nippon Medical School Tama-Nagayama Hospital.

Subjects

We selected the subjects for this first cross-sectional pilot study from the examinees undergoing a national insurance annual checkup and limited their age to between 65 and 74 years old: the upper age range of individuals participating in this checkup. The examinations were performed mainly at the primary care clinics in the private sector. The primary care doctors were asked to perform the "Yubi-wakka" (finger-ring) test, but the test was not mandatory. A total of 5,405 data points (from 72.7% of all examinees of this age range) were obtained.

Methods

"Yubi-wakka" (finger-ring) test

The detailed method of this test is explained elsewhere [1, 3]; briefly, the examinee surrounded his or her non-dominant calf using their own finger-ring (both thumbs and index fingers), while they were in a sitting position, and whether the calf was "larger", "just fit" or "smaller" than the finger-ring was determined. At the beginning of the study, a written request for the registered local practitioners to participate in this study was delivered. The request also explained how to perform this method using pictures.

National insurance annual checkup in Tama city

Anthropologic data such as body height, weight, waist circumference and blood pressure were measured. Blood (nutritional, liver, kidney, lipids, glucose, blood cell counts, etc.) and urine samples were taken along with simple medical history questions.

Statistical analysis

We analyzed the relationships between the "Yubi-wakka" (finger-ring) test results and the other data. We excluded the intermediate, "just fit" group and compared the remaining two groups ("larger" and "smaller"). We used Student's *t*-tests to compare the groups and the Chi-squared analysis to analyze prevalence. We used a logistic regression test to adjust for multiple variables. These statistical analyses were performed using SPSS version 23.0 (IBM, Armonk, NY, USA).

Results

We obtained 5,405 data points. In total, 38.8% of the subjects' calves were judged as "larger" than their finger-ring, 45.6% of the subjects were in the "just fit" group and 15.6% were in the "smaller" group (Table 1). More than 30 clinics participated in this pilot study. The positive rate (the prevalence of the subjects who were in the "smaller" group) varied from 6.3% to 34.6% (Fig. 1). The positive rate was not related to the number of examinees, age, female sex, or diabetes.

Table 2 shows the comparison of anthropologic data between the "larger" and "smaller" groups in both sexes. Comparing the "smaller" group (positive) to the "larger" group, it was found that in the "smaller" group, the average height was higher, the average body weight was lower and they tended to lose weight in consecutive years. The blood pressure in the females was lower.

The average body mass index (BMI) of the "larger" group was greater than 24, and the average waist circumference was 89 cm in males.

The positive group had lower HbA1c levels and lower red blood cell counts in both sexes; higher high-density lipoprotein cholesterol (HDL-C) levels and lower triglyceride, alanine transaminase (ALT) and uric acid levels were also observed. Creatinine was not significantly different, but creatinine kinase and albumin levels were lower in males (Table 3).

The Japanese definition of metabolic syndrome (MetS) is the presence of central obesity combination with any two of the following conditions: elevated triglycerides ($\geq$ 150 mg/dL); lowered HDL-C (< 40 mg/dL); elevated blood pressure (systolic blood pressure $\geq$ 130 mm Hg and/or diastolic blood pressure $\geq$ 85 mm Hg); and raised fasting glucose ($\geq$ 110 mg/dL). Cutoff level used for the waist circumference to define central obesity is 85 cm for male and 90 cm for female [4]. Pre-MetS was defined as central obesity with one positive among other conditions. The prevalence of MetS and pre-MetS was significantly higher in the "larger" group (Table 4).

A logistic regression test was performed (Table 5). Low BMI was an independent risk factor in both sexes. Positive urinary glucose, higher aspartate aminotransferase (AST) and systolic blood pressure and low ALT were risk factors for positive test results for males. Smoking, high hemoglobin and old age were risk factors for positive test results in females.

Discussion

Although the "Yubi-wakka" (finger-ring) test was described in the original paper [1] as a self-screening tool, it was expected to be performed in a half-self-screened manner under the observation of medical staff in an ordinary primary care setting. However, the medical staff only read the explanation and were

Table 1. Distribution of Results of Finger-Ring Test

Male				
n (%)	2,129 (39.4)			
Finger-ring test	Larger	Just fit	Smaller	Sum
65 - 69 years old	370 (43.0)	381 (44.3)	110 (12.8)	861 (100, 40.4)
70 - 74 years old	489 (38.6)	594 (46.8)	185 (14.6)	1,268 (100, 59.6)
Sum	859 (40.3)	975 (45.8)	295 (13.9)	2,129 (100, 100)
Female				
n (%)	3,276 (60.6)			
Finger-ring test	Larger	Just fit	Smaller	Sum
65 - 69 years old	541 (36.8)	690 (46.9)	240 (16.3)	1,471 (100, 44.9)
70 - 74 years old	696 (38.6)	802 (44.4)	307 (17.0)	1,805 (100, 55.1)
Sum	1,237 (37.8)	1,492 (45.5)	547 (16.7)	3,276 (100, 100)
All				
n (%)	5,405 (100)			
Finger-ring test	Larger	Just fit	Smaller	Sum
6 5- 69 years old	911 (39.1)	1,071 (45.9)	350 (15.0)	2,332 (100, 43.1)
70 - 74 years old	1,185 (38.6)	1,396 (45.4)	492 (16.0)	3,073 (100, 56.9)
Sum	2,096 (38.8)	2,467 (45.6)	842 (15.6)	5,405 (100, 100)

not trained for the test.

Compared to the description in the original paper [1], the average age was similar at 70 years, and the positive rate, judged as "smaller", seemed to be the same in males but higher in females (17% vs. 15%) in our population. Additionally, the proportion of those in the "larger" group was lower (39% vs. 53%), and the proportion of participants in the "just fit" group was larger in our population (46% vs. 33%). We considered that one of the reasons for these differences was a difference in the subject characteristics. In the original paper [1], subjects were invited to the cohort study, so there was likely a participant bias. On the other hand, annual checkup examinees are relatively health-conscious, but more than 60% of them visit clinics regularly because of chronic diseases, such as hypertension, hyperlipidemia and diabetes. Additionally, the positive rate differed from 6.3% to 34.6% among clinics. We could not
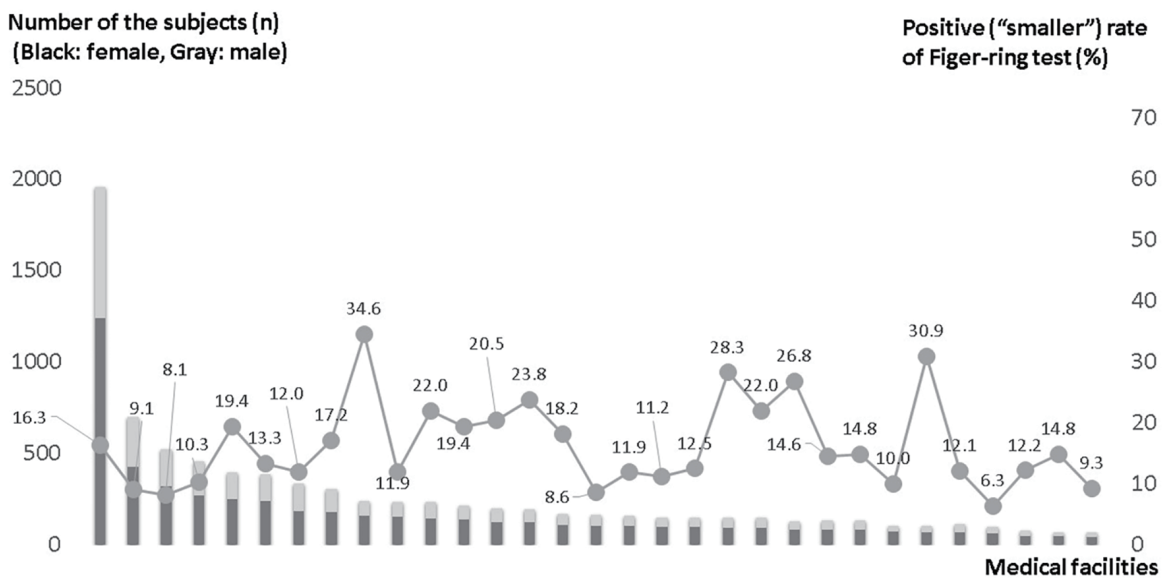

Figure 1. Positive rate of finger-ring test among medical facilities.

Table 2. Comparison of Anthropological Data Between "Larger" and "Smaller" Groups

	Male			Female		
	Larger	**Smaller**	**P-value**	**Larger**	**Smaller**	**P-value**
n	859	295		1,237	547	
Age (years)	70.1	70.5*	0.036*	70.1	70.2	0.289
Body height (cm)	165.8	166.7*	0.022*	151.9	152.8*	0.002*
Body weight (kg)	68.6*	58.0	0.000*	55.4*	46.0	0.000*
Body mass index	24.9*	20.8	0.000*	24.0*	19.7	0.000*
Waist circumference (cm)	89.1*	79.2	0.000*	85.4*	75.1	0.000*
Change in body weight over 3 years (dBW 3 years) (kg)	0.2*	-0.9	0.000*	0.3*	-0.6	0.000*
dBW 5 years (kg)	0.2*	-1.2	0.000*	0.2*	-0.8	0.000*
Body weight 2012 (kg)	67.9*	58.8	0.000*	55.3*	46.5	0.000*
Body weight 2014 (kg)	68.1*	58.4	0.000*	55.1*	46.4	0.000*
Body mass index 2012	24.6*	21.1	0.000*	23.7*	19.7	0.000*
Body mass index 2014	24.6*	21.0	0.000*	23.8*	19.8	0.000*
Systolic blood pressure (mm Hg)	130.7	130.5	0.877	129.3*	126.8	0.0003*
Diastolic blood pressure (mm Hg)	76.0	75.4	0.356	73.5*	72.0	0.004*

Data are means. *Significantly higher than those which in the other group.

Table 3. Comparison of Serological Data Between "Larger" and "Smaller" Groups

	Male			Female		
	Larger	**Smaller**	**P-value**	**Larger**	**Smaller**	**P-value**
Hemoglobin A1c (%)	5.9*	5.8	0.009*	5.8*	5.6	0.000*
Fasting plasma glucose (mg/dL)	104.8	101.7	0.090	100.6*	94.5	0.000*
Red blood cell ($\times 10^4/mm^3$)	469.8*	457.5	0.000*	442.6*	437.2	0.004*
Hb (g/dL)	14.7*	14.4	0.000*	13.4	13.3	0.262
Ht (%)	44.6*	43.7	0.000*	41.4	41.1	0.076
High-density lipoprotein (mg/dL)	55.7	62.5*	0.000*	65.7	72.3*	0.000*
Low-density lipoprotein (mg/dL)	116.8*	111.1	0.002*	125.9	126.5	0.650
Triacylglycerols (mg/dL)	135.6*	112.5	0.000*	112.4*	99.2	0.000*
Cr (mg/dL)	0.9	0.9	0.665	0.7*	0.6	0.031*
Estimated glomerular filtration rate (mL/min/1.73 m^2)	67.9	72.0*	0.000*	70.5	72.8*	0.002*
Creatinine clearance (mL/min)	77.6*	68.4	0.000*	72.7*	61.9	0.000*
Creatine kinase (mg/dL)	146.5*	123.5	0.000*	110.4	106.4	0.302
Albumin (mg/dL)	4.3*	4.2	0.000*	4.3	4.3	0.854
Aspartate aminotransferase (IU/L)	26.1	25.5	0.391	25.8	24.0	0.331
Alanine aminotransferase (IU/L)	24.7*	19.5	0.000*	21.6*	17.8	0.000*
Gamma glutamyl transpeptidase (IU/L)	45.0	51.8*	0.000*	28.8*	26.0	0.033*
Alkaline phosphatase (mg/dL)	208.3	230.1*	0.000*	228.7*	221.2	0.026*
Amylase (mg/dL)	85.1	94.0*	0.000*	81.9	91.3*	0.000*
Uric acid (mg/dL)	6.0*	5.8	0.001*	4.9*	4.6	0.000*
Fe (mg/dL)	110.8	108.1	0.261	100.2	100.2	0.074

Data are means. *Significantly higher than those which in the other group.

Table 4. Distribution of the Metabolic Syndrome (%; Chi-Squared Test) and Pre-MetS in "Lager" and "Smaller" Groups

	Male			Female		
	Larger	**Smaller**	**P-value**	**Larger**	**Smaller**	**P-value**
No	36	82.7	0.001	73.3	96.3	0.001
Pre-metabolic syndrome	22.9	7.1		0	0	
Metabolic syndrome	41.1	10.2		17.9	2.2	

Metabolic syndrome: central obesity (85 cm for male and 90 cm for female) with any two of triacylglycerol ≥ 150 mg/dL; high-density lipoprotein < 40 mg/dL; systolic blood pressure ≥ 130 mm Hg and/or diastolic blood pressure ≥ 85 mm Hg; and fasting glucose ≥ 110 mg/dL. Pre-metabolic syndrome: central obesity with one positive among others.

find differences in the examinees' backgrounds; however, an older clinic might attend patients with a longer duration of illness. Additionally, there might have been unknown methodological differences in some clinics.

Because of the uncertainty of the methodology, we excluded the intermediate "just fit" group and selected the "larger" and "smaller" groups for comparison.

"Yubi-wakka" (finger-ring) is considered to be a method to adjust for body size differences by using the finger-ring of the individual being examined; however, taller people have relatively larger finger-ring circumferences, so they tended to be classified as "smaller".

Because of the age limitation of the national insurance checkups, the age range of 65 to 75 years might be too young to detect frailty. In fact, the "larger" group accounted for 40% of all subjects, and their average BMI and waist circumference were the same as the criteria for obese and MetS. Creatinine kinase and AST could be markers of muscle mass, and ALT might be related to fatty liver. Almost 40% of all patients would benefit from the modifying multiple risk factors, such as obesity, high blood pressure, high plasma glucose, elevated lipids and fatty liver, rather than undergoing an intervention for the prevention of frailty.

From the results of multiple regression analysis, the relationship between low body weight and the existence of urinary glucose was understandable. Liver function may be related to fatty liver and/or alcohol consumption. The reason for

Table 5. Multiple Logistic Regression Analysis of the Positive Results of the Finger-Ring Test

	Hazard ratio	P-value
Male ($R^2 = 0.520$, n = 936)		
Urinary glucose	1.528	0.0320
Aspartate aminotransferase	1.046	0.0260
Systolic blood pressure	1.019	0.0390
Alanine aminotransferase	0.965	0.0290
Body mass index	0.526	0.0001
Female ($R^2 = 0.505$, n = 1,411)		
Smoking	2.563	0.0020
Hb	1.384	0.0001
Age	1.063	0.0280
Body mass index	0.537	0.0001

the positive relationship between systolic blood pressure and hemoglobin in the "smaller" group is also unknown. Because this study was cross-sectional, we could not explain the causal relationship, but atherosclerosis, chronic inflammation, kidney function, etc. can be comorbidities of sarcopenia.

An intervention for the "smaller" group to prevent frailty could be useful because many of the individuals in the "smaller" group already had a comorbidity, and the risk of frailty in the future was proven in a previous study [1].

Changing the definition of old age [5] from 65 to 75 has been considered. The health status of elderly individuals has generally improved. The problem of frailty and disability has not disappeared but has carried over to older generations.

The health status of older generations varies, and individual problems should be carefully evaluated.

Although the "Yubi-wakka" (finger-ring) test is simple enough for us to perform and saves both time and cost, it does not directly measure muscle strength or muscle mass, and it also cannot identify "sarcopenic obesity".

We are planning to continue this test in annual checkups on occasion prospectively and to expand to the older generation to evaluate the suitability of this test for implementation as a city policy.

Conflict of Interest

EK received remuneration from Daiichi-Sankyo, Bristol-My-

ers Squibb and Ono Pharmaceutical.

Informed Consent

Not applicable.

Author Contributions

HF performed research including data collection, analysis and wrote the paper. HN, HS and YT performed research including data collection, and participated discussion. HT and EK designed research, study and provided expert clinical knowledge to revise critically.

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