ROC curves of UGS, LEP score, UEP score, and overall score were compared using the DeLong method (DeLong et al., 1988) implemented in the statistical software Analyse-It for Microsoft Excel. Independent variables used in the present study included UGS, LEP score, UEP score, and overall score, whereas, each functional status was a dependent variable. An AUC between 0.7 and 0.8 is considered acceptable discrimination, between 0.8 and 0.9 is considered excellent discrimination, and greater than 0.9 is considered outstanding discrimination (Hosmer and Lemeshow, 2000).

We used an alpha level of 0.05 to determine statistical significance, and all statistical analyses were performed using SPSS statistics Version 18.0 (SPSS Inc., Chicago, IL, USA).

3. Results

Table 1 summarizes descriptive details of the study participants. Mean age ± SD of the study participants ($n = 701$) was 74.3 ± 6.3 (range 65–96). There were 252 (36.4%) participants with low physical function, 137 (20.7%) with low higher-level functional capacity, 287 (41.4%) with mobility limitation, 70 (10.1%) with ADLs disability, and 174 (25.1%) that had experienced falls.

Table 2 presents ORs and 95% CIs for our five functional status according to participants' UGS, LEP score, UEP score, and overall score results, with adjustment for potential confounders. In the sample participants, the 1.0 m/s cut-off value for UGS corresponded to the 22.7th percentile. We used the same percentile to identify the cut-off values for the LEP score (low-performance group < −0.60), UEP score (low-performance group < −0.72), and overall score (low-performance group < −0.55). The UGS, LEP score, UEP score, and overall score were all significantly associated with each functional status.

Table 3 shows the AUCs of the UGS, LEP score, UEP score, and overall score for each functional status. All ROC curves were significantly different from a diagonal line (AUC = 0.5) that indicates zero discriminating ability of the tests. The UGS, LEP score, UEP score, and overall score all had at least acceptable discriminating power (AUC ≥ 0.7) for each functional status with the exception of any falls (AUC = 0.61, 0.62, 0.59, and 0.62, respectively).

We did not detect any significant differences between the AUCs of UGS and LEP score for each functional status. The UEP score had significantly smaller AUCs for low physical function (0.73) and mobility limitation (0.78) than UGS alone (0.81 and 0.85, respectively), LEP score (0.81 and 0.85, respectively), and overall score (0.80 and 0.85, respectively). Although the overall score had a significantly greater AUC for low higher-level functional capacity (0.83) than UGS alone (0.78) and the other composite scores (0.80 for LEP; 0.80 for UEP), the difference was only 3-5%. Similarly, although the AUC of the overall score for ADLs disability (0.83) was significantly greater than the AUC of UGS alone (0.80), the difference was only 3%. We did not detect any other significant differences between the AUCs of any of our scoring methods for the other functional status.

Table 1
Characteristics of the study participants ($n = 701$).

Characteristics	Mean ± SD or n (%)
Age, years	74.3 ± 6.3
Body mass index, kg/m^2 ($n = 699$)	23.6 ± 3.4
Frequency of weekly outings, days/week ($n = 680$)	5.8 ± 2.0
Conditions, n (%)	
Stroke ($n = 695$)	26 (3.7)
Hypertension ($n = 695$)	302 (43.5)
Diabetes mellitus ($n = 696$)	58 (8.3)
Heart disease ($n = 695$)	73 (10.5)
Respiratory disease ($n = 696$)	26 (3.7)
Dyslipidemia ($n = 695$)	92 (13.2)
Low-back pain ($n = 691$)	245 (35.5)
Knee pain ($n = 692$)	234 (33.8)
Performance measures	
UGS, m/s	1.2 ± 0.3
LEP score	−0.19 ± 1.10
Tandem stance, s	25.3 ± 8.3
chair stand test, s	8.5 ± 3.5
Alternate step, s	5.1 ± 1.8
Timed up-and-go, s	7.9 ± 3.8
UEP score	−0.02 ± 1.00
Hand-grip strength, kg	20.7 ± 4.5
Manipulating pegs in a pegboard, pegs	39.0 ± 6.8
Functional reach, cm	25.4 ± 6.6
Overall score	−0.01 ± 1.05
Functional status	
Medical outcomes study 36-item short-form survey, PFI ($n = 693$)	74.3 ± 22.3
Low physical function (PFI < 70)	252 (36.4)
TMIG index ($n = 663$)	11.5 ± 2.1
Low higher-level functional capacity (TMIG index < 11)	137 (20.7)
Mobility limitation, n (%) ($n = 694$)	287 (41.4)
ADLs disability, n (%) ($n = 690$)	70 (10.1)
Any falls in previous year, n (%) ($n = 693$)	174 (25.1)

UGS, usual gait speed; LEP, lower extremity performance; UEP, upper extremity performance; PFI, physical function index; TMIG, Tokyo Metropolitan Institute of Gerontology; ADLs, activities of daily living.
LEP score = 0.031 × tandem stance − 0.106 × chair stand test −0.192 × alternate step −0.096 × timed up-and-go + 1.672.
UEP score = 0.091 × hand-grip strength + 0.063 × manipulating pegs + 0.061 × functional reach −5.901.
Overall score = 0.036 × hand-grip strength + 0.040 × manipulating pegs + 0.026 × functional reach + 0.015 × tandem stance −0.063 × chair stand test −0.117 × alternate step −0.059 × timed up-and-go −1.746.

4. Discussion

Despite UGS being only a single test, its discriminating power was similar to the LEP score for each functional status. Moreover, the UGS alone could discriminate low physical function and mobility limitation more accurately than the UEP score. Interestingly, even the overall score had only a 3–5% difference in AUCs for low higher-level functional capacity and ADLs disability compared with UGS alone, and there were no significant differences in AUCs for any other functional status. Although we investigated whether a derived composite score representing overall physical performance would be a stronger relevant indicator of health problems than UGS alone, our findings indicate that UGS alone may represent overall physical performance and is adequate for assessing a wide range of functional status in older women.

We added timed up-and-go and alternate step test, both of which indicate the ability to perform common mobility tasks integral to daily life, to the chair stand and balance tests for the LEP score, but the present results were not different from previous findings that compared UGS with SPPB (Guralnik et al., 2000; Onder et al., 2005). Therefore, we can conclude that there is no difference between the discriminating power of the UGS and a more complex battery of LEP tests regardless of the measures or method used to construct a performance score.

We consider a difference in the AUCs for low physical function and mobility limitation between UGS alone and UEP score to be meaningful, because the difference in the AUCs is greater than 5%, and 95% CIs did not overlap at all. Our previous study (Seino et al., 2011a) showed that the UGS can discriminate even upper extremity functional limitation almost as well as a combination of different UEP measures. On the other hand, the discriminating power of hand-grip strength alone for mobility limitation was 15% lower than the discriminating power of the LEP score (Seino et al., 2011b). These indicate that the UGS is certainly more important than UEP measures and the UEP score in the routine assessment of functional status.

Table 2
Adjusted* odds ratio and 95% confidence interval (95% CI) for each status according to UGS, LEP score, UEP score, overall score results (n = 701).

Performance measures	Low physical function		Low higher-functional capacity		Mobility limitation		ADLs disability		Any falls	
	Case/participants (%)	Adjusted* OR (95% CI)	Case/participants (%)	Adjusted* OR (95% CI)	Case/participants (%)	Adjusted* OR (95% CI)	Case/participants (%)	Adjusted* OR (95% CI)	Case/participants (%)	Adjusted* OR (95% CI)
UGS										
≥1.0 m/s (high-performance)	131/537 (24.4)	1 (reference)	70/525 (13.3)	1 (reference)	148/536 (27.6)	1 (reference)	25/533 (4.7)	1 (reference)	113/535 (21.1)	1 (reference)
<1.0 m/s (low-performance)	121/156 (77.6)	6.3 (3.8–10.5)	67/138 (48.6)	3.4 (2.0–5.7)	139/158 (88.0)	12.3 (6.8–22.4)	45/157 (28.7)	4.0 (2.1–7.7)	61/158 (38.6)	1.8 (1.1–3.0)
LEP score										
≥−0.60 (high-performance)	132/539 (24.5)	1 (reference)	64/527 (12.1)	1 (reference)	153/538 (28.4)	1 (reference)	23/535 (4.3)	1 (reference)	112/537 (20.9)	1 (reference)
<−0.60 (low-performance)	120/154 (77.9)	5.8 (3.5–9.7)	73/136 (53.7)	4.4 (2.5–7.6)	134/156 (85.9)	7.7 (4.4–13.6)	47/155 (30.3)	5.0 (2.5–10.0)	62/156 (39.7)	2.1 (1.3–3.5)
UEP score										
≥−0.72 (high-performance)	155/539 (28.8)	1 (reference)	72/531 (13.6)	1 (reference)	173/540 (32.0)	1 (reference)	28/535 (5.2)	1 (reference)	118/540 (21.9)	1 (reference)
<−0.72 (low-performance)	97/154 (63.0)	2.3 (1.4–3.7)	65/132 (49.2)	3.0 (1.8–5.0)	114/154 (74.0)	3.7 (2.3–6.2)	42/155 (27.1)	3.7 (1.9–7.2)	56/153 (36.6)	1.8 (1.1–2.9)
Overall score										
≥−0.55 (high-performance)	136/539 (25.2)	1 (reference)	66/529 (12.5)	1 (reference)	157/538 (29.2)	1 (reference)	21/534 (3.9)	1 (reference)	112/538 (20.8)	1 (reference)
<−0.55 (low-performance)	116/154 (75.3)	4.4 (2.6–7.4)	71/134 (53.0)	3.4 (2.0–5.9)	130/156 (83.3)	6.2 (3.6–10.9)	49/156 (31.4)	5.1 (2.5–10.2)	62/155 (40.0)	2.1 (1.3–3.5)

UGS, usual gait speed; LEP, lower extremity performance; UEP, upper extremity performance; ADLs, activities of daily living.
LEP score = 0.031 × tandem stance − 0.106 × chair stand test − 0.192 × alternate step − 0.096 × timed up-and-go + 1.672.
UEP score = 0.091 × hand-grip strength + 0.063 × manipulating pegs + 0.061 × functional reach − 5.901.
Overall score = 0.036 × hand-grip strength + 0.040 × manipulating pegs + 0.026 × functional reach + 0.015 × tandem stance − 0.063 × chair stand test − 0.117 × alternate step − 0.059 × timed up-and-go − 1.746.
Independent variables: UGS, LEP score, UEP score, and overall score.
Dependent variables: each functional status.
* Adjusted for age, body mass index, frequency of weekly outings, stroke, hypertension, diabetes mellitus, heart disease, respiratory disease, dyslipidemia, low back pain, knee pain.

A noteworthy finding of the present study is that UGS alone could discriminate for each functional status almost as well as an overall score derived from 7 performance measures. Although the overall score tended to have slightly greater AUCs for more complicated indicators (i.e., low higher-functional capacity and ADLs disability) which include many daily tasks, Guralnik et al. (2000) have concluded that a 3–5% difference between AUCs is negligible. Our result indicates that the UGS test should not be regarded solely as a measure of lower extremity function, and this single test represents the vast majority of information generally obtained through a number of physical performance tests. In addition, when considering the simplicity of the single measurement for UGS and the cost of spending additional time measuring the parameters for the overall score or any other composite score, UGS alone may suffice in a practical setting, and it would be quite useful as a first screening tool to catch any functional decline at the earliest stage in older women.

The UGS not only represents general physical performance, but may also reflect overall health status because the UGS has been associated with health-related status apparently unrelated to physical performance, such as multimorbidity (Cesari et al., 2006) and cognitive impairment (Deshpande et al., 2009). Studenski et al. (2011) has conducted a pooled analysis of 9 cohort studies (collected between 1986 and 2000), using data from 34,485 community-dwelling older adults aged 65 years or older with baseline UGS data. They showed that baseline UGS scores can predict 5-year and 10-year survival (AUC = 0.717 and 0.737, respectively). Additionally, they also demonstrated that the AUC of age, sex, and UGS model for survival was approximately equivalent to that of the age, sex, and multiple clinical data model (i.e., prevalent chronic diseases, BMI, systolic blood pressure, and history of prior hospitalization). Therefore, a decreasing UGS may be utilized as an important indicator of overall health status.

There were several limitations and agendas in this study. First, population studies of older adults may sometimes be affected by a selection bias, because relatively healthier people tend to participate. We consider that the importance of assessing UGS may increase in people with frailty or aged 75 years and older as shown by Shinkai et al. (2000). Second, this study was a cross-sectional study, which does not allow evaluation of the predictive ability of the composite scores and UGS that we studied. Third, although we were able to adjust our analyses for health information with this study, there could be unmeasured confounders for which we could not adjust. Finally, although the UGS is considered an indicator of overall well-being, it is unclear which status is most tightly associated with a decreasing UGS when we assessed the UGS in a practical setting. In addition, since the AUCs for "any fall" were lower than the AUCs for the other functional status, we see there are adverse-health outcomes that the UGS alone cannot discern (Quach et al., 2011). Detecting people who have a slow UGS at a first screening and then exploring which factors effect their deconditioning using detailed investigative techniques is a realistic method of study in the present stage. In the future, we need to explore how much UGS alone reflects overall health status. Moreover, there is extremely limited evidence as to whether improving a parson's UGS will improve that parson's health status (Hardy et al., 2007). Longitudinal and intervention studies are needed to confirm these agendas described above.

In conclusion, although we hypothesized that the composite LEP score, UEP score or, especially, the overall score would be more sensitive than UGS alone for assessing a wide range of functional status, we found UGS is almost as good as the overall score at discriminating older women with a declining functional status. Therefore, the UGS should not be regarded solely as a measure of lower extremity function, and this single test may represent overall physical performance. Furthermore, when considering the

Table 3
AUCs[a] and 95% confidence interval (95% CI) of UGS, LEP score, UEP score, and overall score for each status.

Physical performance	AUC (95% CI)				
	Low physical function	Low higher-level functional capacity	Mobility limitation	ADLs disability	Any falls
UGS	0.81 (0.78–0.84)	0.78 (0.73–0.82)	0.85 (0.82–0.87)	0.80 (0.73–0.86)	0.61 (0.56–0.66)
LEP score	0.81 (0.77–0.84)	0.80 (0.76–0.85)	0.85 (0.82–0.88)	0.82 (0.76–0.88)	0.62 (0.57–0.67)
UEP score	0.73 (0.70–0.77)*,**,****	0.80 (0.76–0.84)	0.78 (0.75–0.82)*,**,****	0.81 (0.75–0.86)	0.59 (0.54–0.64)
Overall score	0.80 (0.76–0.83)	0.83 (0.79–0.87)*,**,***	0.85 (0.82–0.88)	0.83 (0.78–0.89)*	0.62 (0.57–0.67)

AUC, area under the receiver operating characteristic curve; UGS, usual gait speed; LEP, lower extremity performance; UEP, upper extremity performance; ADLs, activities of daily living.
LEP score = 0.031 × tandem stance − 0.106 × 5 chair sit-to-stands − 0.192 × alternate step − 0.096 × timed up-and-go + 1.672.
UEP score = 0.091 × hand-grip strength + 0.063 × manipulating pegs + 0.061 × functional reach − 5.901.
Overall score = 0.036 × hand-grip strength + 0.040 × manipulating pegs + 0.026 × functional reach + 0.015 × tandem stance − 0.063 × chair stand test − 0.117 × alternate step − 0.059 × timed up-and-go − 1.746.
Independent variables: UGS, LEP score, UEP score, and Overall score.
Dependent variables: each functional status.
[a] Range 0.5–1.0. Degree of discrimination: 0.7–0.8 acceptable, 0.8–0.9 excellent, 0.9–1.0 outstanding.
* $p < 0.05$ vs UGS.
** $p < 0.05$ vs LEP score.
*** $p < 0.05$ vs UEP score.
**** $p < 0.05$ vs Overall score.

cost of additional time spent determining the composite score versus the simplicity of measuring only the UGS, UGS alone may suffice for assessing a wide range of functional status among community-dwelling older women.

Conflict of interest statement

None.

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Comparison of a combination of upper extremity performance measures and usual gait speed alone for discriminating upper extremity functional limitation and disability in older women

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ABSTRACT

Although usual gait speed (UGS) is considered an indicator of overall well-being, it is unclear whether upper extremity performance (UEP) measures provide a similar, additive contribution to functional status. We aimed to identify whether combining UEP measures can more accurately discriminate upper extremity functional limitation (UE limitation) and disability compared to UGS. We conducted a cross-sectional analysis on data from 322 community-dwelling older women, aged 65–96 years. Trained testers assessed UGS, and hand-grip strength (GRIP), functional reach (FR), back scratch, manipulating pegs (PEG), and moving beans with chopsticks as UEP measures. We assessed three functional statuses: UE limitation, activities of daily living (ADLs) and instrumental ADLs (IADLs) disabilities using self-reported questionnaires. Areas under the receiver operating characteristic curves (AUCs) were used to compare the discriminating power of UGS, with the individual and combined UEP measures for each status. Among UEP measures, only GRIP (AUC = 0.68 for UE limitation, 0.81 for IADLs disability, and 0.84 for ADLs disability) could accurately discriminate each status as well as UGS (AUC = 0.65, 0.83, and 0.91, respectively). Furthermore, UGS alone could discriminate UE limitation almost as well as the combination of GRIP, PEG, and FR (AUC = 0.70). Combining other UEP measures did not help discriminate further. There were few advantages to combining UEP measures, and UGS or GRIP alone may suffice for assessing UE limitation and disability. However, the UGS should be the test of first choice, certainly more than GRIP, in routine assessment of functional limitation and disability, including UE limitation.
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1. Introduction

Numerous studies have demonstrated that poor lower extremity performance (LEP) not only correlates cross-sectionally with functional status (e.g., functional limitation and disability), but also predicts them prospectively (Guralnik et al., 1994, 1995, 2000; Shinkai et al., 2000; Cesari et al., 2005; Kim et al., 2010). In particular, gait speed, chair rising, and balance tests, which are included in the short physical performance battery (SPPB) (Guralnik et al., 1994), have been studied to determine the added value of each additional LEP measure in predicting adverse health-related outcomes. Furthermore, UGS has been considered to be the most important predictor of adverse health-related outcomes among LEP measures (Cesari et al., 2009).

Thus, LEP measures, particularly UGS, are largely representative of a person's general health condition, but UEP is also likely to be tightly associated with a person's functional status because of the following: (1) physical functioning can be divided into three components, upper extremity, basic lower extremity, and advanced lower extremity functions (Haley et al., 2002); and (2) several common ADLs, such as dressing, eating, and personal hygiene are mostly upper extremity-related tasks. Notably, the vast majority of women also engage in upper extremity-related IADLs tasks (e.g., cooking, housekeeping, and doing the laundry). Indeed, Hazuda et al. (2005) have shown that their UEP battery of testing makes an independent contribution beyond the SPPB in explaining disability and dependence.

Although several UEP measures are widely used in older adults, it is unclear whether any or all of them provide a similar, additive contribution to our determination of functional status. Compared to one measure alone, combining several UEP measures may

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capture more manifestations of disability, however, it has yet to be determined which, if any, combination of UEP measures is most efficient at detecting functional limitation and disability.

The purpose of this study was to identify whether a combination of UEP measures is better at detecting UE limitation and disability compared to one measure alone, and if so, which combination of UEP measures is most accurate. To verify the value of UEP measures, we compared the discriminating power of each UEP measure alone and in different combinations with the commonly used UGS test, which is well established as a measure of general health (Cesari et al., 2005).

2. Methods

2.1. Participants

A total of 343 community-dwelling older Japanese women participated in this study in 2010. The participants were recruited from the towns of Ibaraki, Chiba, and Fukushima, Japan, as part of a nursing care prevention program or day-care service. Almost all of participants were recruited through local advertisements and flyers. The eligibility criteria were as follows: (1) they must be community dwellers aged 65 years or older; and (2) participants must be able to understand the instructions of performance tests and questionnaires. Participants who required assistance or were too functionally limited to perform the tests safely and participants with missing data of UEP measures were excluded. The remaining 322 participants included in this study ranged in age from 65 to 96 years. All participants provided written informed consent. This study was conducted in accordance with the guidelines proposed in the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of the University of Tsukuba, Japan.

2.2. Measurements

2.2.1. UGS

Participants were instructed to stand with their feet behind and just touching a starting line marked with tape at 0 m and, on receiving the tester's command, to start walking at their normal pace along a 7 m course. The actual walking speed was measured over 5 m starting with the first footfall past the 1 m mark and ending with the first footfall after the 6 m mark. Participants performed two trials with results averaged to the nearest 0.01 m/s (Shinkai et al., 2000). The reliability of UGS was excellent, with an intraclass correlation coefficient (ICC) of 0.97.

2.2.2. UEP measures

UEP components for performing ADLs included upper body strength, flexibility, and dexterity. We selected the following performance tests as indicators for these components: hand-grip strength (GRIP), functional reach (FR), back scratch (BS), manipulating pegs in a pegboard (PEG), and moving beans with chopsticks (BEAN). In selecting these items for assessing UEP, we referred to test selection criteria (Rikli and Jones, 1999) and studies by Hazuda et al. (2005), Tanaka et al. (1995), Shigematsu and Tanaka (2000), Syddall et al. (2003), Rikli and Jones (1999), and others. Participants could complete the 5 tests within 20 min and were not fatigued.

GRIP. We measured GRIP using a hand-held dynamometer (GRIP-D, T.K.K 5401; Takei Scientific Instruments, Tokyo, Japan). Participants were in a standing position with their arms hanging naturally at their sides. They were instructed and verbally encouraged to squeeze the hand-grip as hard as they could. Grip size was adjusted to a comfortable level for the participant. Participants performed two trials with each hand alternately, and the results were average to the nearest 0.1 kg. The reliability of the GRIP was excellent, with an ICC of 0.95.

FR. According to the measuring method devised by Duncan et al. (1992), participants stood with their feet together, their bodies perpendicular to and with one shoulder adjacent to, but not touching, a wall which had a measuring yardstick affixed to it horizontally. They raised their arms in front of them to a horizontal position with their tips of the middle fingers positioned at the zero end of the measuring yardstick. They reached forward as far as possible, bending as necessary but keeping their arms straight and horizontal and their feet in the starting position. The distance from beginning position to ending position as measured at the tips of the middle fingers was the FR value. We measured FR two times and recorded the average to the nearest 1 cm. Although the FR test was originally developed as a measure of dynamic balance, it involves movement of the upper extremities and is required for many upper body tasks (Hazuda et al., 2005). The reliability of FR was excellent, with an ICC of 0.95.

BS. Participants were asked to place the preferred hand behind the same-side shoulder, palm toward back and fingers extended, reaching down the middle of the back as far as possible (elbow pointed up) in a standing position. They placed the other hand behind the back, palm out, reaching up as far as possible in an attempt to touch or overlap the extended middle fingers of both hands. We measured the distance between (or the overlap of) the middle fingers behind the back two times and recorded the average to the nearest 1 cm. If their middle fingers could not touch, we recorded the value as minus. If their middle fingers could overlap, we recorded the value as plus. The participants were not allowed to grab fingers together and pull (Rikli and Jones, 1999). The reliability of the BS was considered acceptable, with an ICC of 0.88.

PEG. For this test, we used a pegboard (hand working test instrument, T.K.K 1306; Takei Scientific Instruments, Tokyo, Japan) consisting of 48 pegs arranged in a six by eight matrix on the side of the board distal to where the participants stood. With the board situated close to and at the midline of the body, participants were instructed to manipulate the pegs as fast as possible, one by one, using both hands, from the far side of the board to the near side. We recorded the number of pegs relocated within 30 s during 1 trial (Shigematsu and Tanaka, 2000). We evaluated this test's reliability using 22 of the participants; we considered it acceptable, with an ICC of 0.88. Shigematsu and Tanaka (2000) demonstrated an ICC with the PEG test of 0.82.

BEAN. The participants used chopsticks to transfer as many beans as possible (approximately 0.8 cm in diameter) from one dish (2.0 cm in depth, 20.0 cm in diameter) to another (3.5 cm in depth, 6.0 cm in diameter) within 30 s. The dishes were 20 cm apart. We recorded the number of beans correctly transferred during one 30 s trial (Shigematsu and Tanaka, 2000). This evaluation was modified from a previous study by Kim and Tanaka (1995) in which pincers rather than chopsticks were used. Shigematsu and Tanaka (2000) arrived at an ICC of BEAN of 0.84, which was considered acceptable.

2.2.3. UE limitation and disability status

From a self-reported questionnaire, we determined a participant's UE limitation using a severity of UE limitation scale (Simonsick et al., 2001), which assesses the degree of difficulty in performing three primarily upper extremity actions (i.e., using fingers to grasp or handle something, lifting and carrying 10 lbs, and raising arms up over the head). Response categories were no difficulty, a little difficulty, some difficulty, a lot of difficulty, and unable to do. Participants who reported any difficulty with these three activities were rated as having UE limitation.

Disability status was assessed using IADLs (Lawton and Brody, 1969) and ADLs (Mahoney and Barthel, 1965) scales. The IADLs include the ability to use the telephone, shop, prepare food, perform housekeeping chores, do laundry, use a mode of transportation, maintain responsibility for own medications, and handle finances. The ADLs include aspects of eating, moving from

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bed to chair, grooming, toilet use, bathing, ambulation, negotiating stairs, dressing, emptying bowels and bladder. IADLs and ADLs disabilities were defined as a participant being unable to perform or needing human help with one or more IADL or ADL tasks, respectively (Lawton and Brody, 1969).

2.2.4. Potential confounders

Several potential confounders were included in our analyses: age; body mass index (BMI), defined as body weight divided by height squared (kg/m^2); frequency of weekly outings; clinical conditions (history of stroke, hypertension, diabetes mellitus, heart disease, respiratory disease, and dyslipidemia); and joint pain (presence of shoulder pain, low-back pain, or knee pain). All of these were computed on the basis of self-report questions.

2.3. Statistical analyses

We used descriptive statistics to characterize the study participants and performed multiple logistic regression analyses to evaluate whether UGS and each UEP measure alone were significantly associated with UE limitation, IADLs disability, or ADLs disability. Cesari et al. (2005) demonstrated that the prognostic value of UGS for identifying people at high risk of health-related outcomes was 1.0 m/s. In our analyses, we used the 1.0 m/s cut-off value to dichotomize UGS into high- and low-performance groups. GRIP, FR, BS, PEG, and BEAN were dichotomized using the same percentile (21.7%) as the chosen UGS cut-off value. By choosing this same threshold to identify individuals at a low-performance level, we determined equal distributions of the performance measures of interest, consequently allowing fair comparisons (Cesari et al., 2009). We calculated the odds ratio (OR) and 95% confidence interval (95% CI) for each functional status (i.e., UE limitation, IADLs disability, and ADLs disability) according to our two categories after adjusting for potential confounders: the high-performance category, which we considered a reference group; and the low-performance category. We also performed these analyses considering continuous variables for each UEP measure. The continuous variables of performance measures were rescaled to standardized score (i.e., average per standard deviation).

To compare the discriminating power of an individual UEP measure and their combination for each status, we conducted receiver operating characteristic (ROC) analyses. We compared the areas under the ROC curves (AUCs) using the DeLong method (DeLong et al., 1988) implemented in the statistical software Analyse-It for Microsoft Excel. An AUC between 0.7 and 0.8 is considered acceptable discrimination, between 0.8 and 0.9 is considered excellent discrimination, and greater than 0.9 is considered outstanding discrimination (Hosmer and Lemeshow, 2000).

We used an alpha level of 0.05 to determine statistical significance, and all statistical analyses were performed using SPSS statistics Version 18.0 (SPSS Inc., Chicago, IL, USA).

3. Results

Table 1 summarizes descriptive details of the study participants. Mean age ± standard deviation of the study participants was 75.6 ± 6.7 (range 65–96). The numbers of participants reporting UE limitation, IADLs disability, and ADLs disability were 117 (37.6%), 68 (22.4%), and 40 (12.5%), respectively.

Table 2 presents ORs and 95% CIs for UE limitation, IADLs disability, and ADLs disability according to performance measures results with adjustments for potential confounders. In the sample participants, the 1.0 m/s cut-off value for UGS corresponded to the 21.7th percentile. We used the same percentile to identify the cut-off values for GRIP (low-performance group < 16.8 kg), FR (low-performance group < 20.1 cm), BS (low-performance group < −15.0 cm), PEG (low-performance group < 34 pegs), and BEAN (low-performance group < 7 beans). The UGS was consistently associated with each functional status as both categorical and continuous variables. When looking at individual UEP measures, only GRIP and PEG tests were consistently associated with each status as both categorical and continuous variables. Although BS was significantly associated with IADLs and ADLs disabilities as both categorical and continuous variables, it was not associated with UE limitation. As a categorical variable, FR was significantly associated with each status, whereas, as a continuous variable, it was not associated with IADLs disability. BEAN was not significantly associated with any status as either a categorical or a continuous variable.

Through multiple logistic regression analyses, we set up the following 4 combination patterns of UEP measures: (1) GRIP + PEG, which was consistently associated with each status as both categorical and continuous variables, (2) GRIP + PEG + FR, (3) GRIP + PEG + BS and (4) GRIP + PEG + FR + BS. Each combination was represented by simple addition of the standardized score of individual measures. Since BEAN was not associated with any status, we did not include it in the combination patterns.

Table 3 shows the AUC and 95% CI for UGS, each individual UEP measure, and combinations of UEP measures for each status. All ROC curves were significantly different from a diagonal line (AUC = 0.5) that indicates zero discriminating ability of the tests. Among the individual measures, GRIP had the greatest AUC for UE limitation (0.68), and UGS had the greatest AUCs for IADLs and ADLs disabilities (0.83 and 0.91, respectively). Only GRIP's AUCs were not significantly different from the AUCs of UGS for any status. The AUC for PEG alone was nearly equal to that for GRIP alone. The AUCs of FR and BS were consistently lower than any other measures alone or in combination.

For the UE limitation, we did not detect any significant differences between the AUCs of UGS (0.65) and the individual UEP measures. The AUCs of GRIP + PEG (0.69) and GRIP + PEG + FR (0.70) for UE limitation were significantly greater than UGS alone, but the 4–5% difference between AUCs was not substantial.

Table 1
Characteristics of the study participants (n = 322).

Characteristics	Mean ± SD or n (%)
Age (years) (n = 322)	75.6 ± 6.7
Height (cm) (n = 322)	146.9 ± 6.4
Weight (kg) (n = 322)	50.6 ± 7.8
BMI (kg/m^2) (n = 322)	23.5 ± 3.4
Frequency of weekly outings (days/wk) (n = 314)	6.1 ± 1.8
Conditions, n (%)	
Stroke (n = 316)	10(3.5)
Hypertension (n = 317)	148(46.7)
Diabetes mellitus (n = 317)	17(5.4)
Heart disease (n = 317)	34(11.0)
Respiratory disease (n = 317)	13(4.1)
Dyslipidemia (n = 317)	58(18.3)
Shoulder pain (n = 318)	32(10.1)
Low back pain (n = 318)	90(28.3)
Knee pain (n = 318)	100(31.4)
UGS (m/s) (n = 317)	1.23 ± 0.32
UEP measures (n = 322)	
GRIP (kg)	20.1 ± 4.6
FR (cm)	24.8 ± 7.1
BS (cm)	−6.7 ± 11.0
PEG, number of pegs	38.4 ± 7.0
BEAN, number of beans	9.2 ± 3.6
Self-reported functional status, n (%)	
UE limitation (n = 311)	117(37.6)
IADLs disability (n = 304)	68(22.4)
ADLs disability (n = 319)	40(12.5)

SD, standard deviation; BMI, body mass index; UGS, usual gait speed; GRIP, hand-grip strength; FR, functional reach; BS, back scratch; PEG manipulating pegs; BESN, moving beans with chopsticks; UE limitation, upper extremity functional limitation; IADLs, instrumental activities of daily living; ADLs, activities of daily living.

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Table 2
Adjusted odds ratio for each status according to performance measures results (n = 322).

Performance measures	Cases/participants (%)			Adjusted odds ratio (95% confidence interval)		
	UE limitation 117/311 (37.6)	IADLs disability 68/304 (22.4)	ADLs disability 40/319 (12.5%)	UE limitation	IADLs disability	ADLs disability
UGS						
>=1 m/s (high-performance)	77/242 (31.8)	28/235 (11.9)	6/245 (2.4)	1 (reference)	1 (reference)	1 (reference)
<1 m/s (low-performance)	38/64 (59.4)	38/64 (59.4)	32/69 (46.4)	2.20 (1.10–4.40)*	3.00 (1.30–6.89)*	21.60 (6.70–69.65)***
Continuous				0.65 (0.46–0.91)*	0.36 (0.21–0.60)***	0.09 (0.04–0.21)***
GRIP						
>=16.8 kg (high-performance)	74/246 (30.1)	32/242 (13.2)	13/251 (5.2)	1 (reference)	1 (reference)	1 (reference)
<16.8 kg (low-performance)	43/65 (66.2)	36/62 (58.1)	27/68 (39.7)	2.94 (1.45–5.96)**	3.20 (1.39–7.36)**	6.18 (2.38–16.04)***
Continuous				0.54 (0.39–0.75)***	0.40 (0.25–0.65)***	0.28 (0.16–0.49)***
FR						
>=20.1 cm (high-performance)	78/244 (32.0)	32/238 (13.4)	17/249 (6.8)	1 (reference)	1 (reference)	1 (reference)
< 20.1 cm (low-performance)	39/67 (58.2)	36/66 (54.5)	23/70 (32.9)	1.99 (1.03–3.84)*	2.93 (1.35–6.34)**	2.92 (1.20–7.09)**
Continuous				0.64 (0.45–0.87)**	0.69 (0.46–1.03)	0.63 (0.40–0.97)*
BS						
>=−15.0 cm (high-performance)	83/247 (33.6)	41/244 (16.8)	19/253 (7.5)	1 (reference)	1 (reference)	1 (reference)
<−15.0 cm (low-performance)	34/64 (53.1)	27/60 (45.0)	21/66 (31.8)	1.55 (0.81–2.97)	2.66 (1.11–6.35)*	4.40 (1.73–11.24)**
Continuous				0.79 (0.59–1.05)	0.54 (0.35–0.83)**	0.38 (0.24–0.61)***
PEG						
>=34 pegs (high-performance)	80/251 (31.9)	36/247 (14.6)	15/256 (5.9)	1 (reference)	1 (reference)	1 (reference)
<34 pegs (low-performance)	37/60 (61.7)	32/57 (56.1)	25/63 (39.7)	2.78 (1.39–5.58)**	2.61 (1.12–6.06)*	4.14 (1.63–10.55)**
Continuous				0.35 (0.21–0.58)***	0.40 (0.24–0.65)***	0.35 (0.21–0.58)***
BEAN						
>=7 beans (high-performance)	77/235 (32.8)	41/231 (17.7)	22/243 (9.1)	1 (reference)	1 (reference)	1 (reference)
<7 beans (low-performance)	40/76 (52.6)	27/73 (37.0)	18/76 (23.7)	1.88 (0.95–3.34)	1.84 (0.80–4.23)	2.37 (0.99–5.63)
Continuous				0.80 (0.61–1.04)	0.68 (0.44–1.04)	0.65 (0.40–1.06)

UE limitation, upper extremity functional limitation; IADLs, instrumental activities of daily living; ADLs, activities of daily living; UGS, usual gait speed; GRIP, hand-grip strength; FR, functional reach; BS, back scratch, PEG manipulating pegs; BESN, moving beans with chopsticks. Odds ratio: adjusted for age, body mass index, frequency of weekly outings, stroke, hypertension, diabetes mellitus, heart disease, respiratory disease, dyslipidemia, shoulder pain, low back pain, knee pain. The continuous variables of performance measures were rescaled to standardized score (i.e., average per standard deviation).

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

For the IADLs disability, we did not detect a difference between the AUCs of UGS (0.83), GRIP (0.81) and PEG (0.83), however, all three were significantly higher than the AUCs of FR and BS (0.73 and 0.68, respectively). Although the AUC of GRIP + PEG (0.86) was significantly greater than the AUC of GRIP alone, the difference was only 5%.

For the ADLs disability, the AUCs of the individual UEP measures, with the exception of GRIP, were significantly lower than the AUC of UGS (0.91). When we increased the number of combined UEP measures, the differences were not significant between the AUC for any combination compared to the AUCs of UGS, GRIP (0.84), or PEG (0.81).

4. Discussion

Among UEP measures, only GRIP could accurately discriminate each status as well as UGS. Interestingly, despite UGS being a test of lower extremity function, this single test could discriminate UE limitation as well as the GRIP test. Moreover, even when we added PEG and then FR in combination with GRIP, there was only a 4–5% difference in their AUCs for UE limitation compared with UGS alone. Adding any other UEP measure to the GRIP + PEG combination did not increase the discriminating power for each status. Therefore, our study suggests that combining UEP measures has few advantages, and the implementation of UGS should be

Table 3
AUCs for each status according to each performance measure alone and combinations of UEP (n = 322).

Performance measures	AUC* (95% confidence interval)		
	UE limitation	IADLs disability	ADLs disability
UGS	0.65 (0.58–0.71)	0.83 (0.78–0.89)	0.91 (0.85–0.97)
UEP measures			
GRIP	0.68 (0.62–0.74)	0.81 (0.75–0.88)	0.84 (0.77–0.92)
PEG	0.66 (0.60–0.73)	0.83 (0.77–0.89)	0.81 (0.73–0.90)[a]
FR	0.63 (0.57–0.70)	0.73 (0.66–0.81)[a,b,c]	0.78 (0.70–0.87)[a]
BS	0.59 (0.53–0.66)[b]	0.68 (0.60–0.75)[a,b,c]	0.77 (0.70–0.85)[a]
Combinations of UEP measures			
GRIP + PEG	0.69 (0.63–0.75)[a,c,d,e]	0.86 (0.80–0.91)[b,d,e]	0.86 (0.78–0.93)[d]
GRIP + PEG + FR	0.70 (0.64–0.76)[a,c,d,e]	0.85 (0.80–0.91)[d,e]	0.87 (0.81–0.94)[d]
GRIP + PEG + BS	0.65 (0.59–0.72)[e]	0.81 (0.75–0.87)[d,e]	0.87 (0.82–0.93)[d,e]
GRIP + PEG + FR + BS	0.67 (0.61–0.73)[e]	0.83 (0.77–0.88)[d,e]	0.88 (0.83–0.94)[d,e]

AUC, area under the receiver operating characteristic curve; UGS, usual gait speed; UEP, upper extremity performance; GRIP, hand-grip strength; PEG manipulating pegs; FR, functional reach; BS, back scratch; UE limitation, upper extremity functional limitation; IADLs, instrumental activities of daily living; ADLs, activities of daily living.

[a] $p < 0.05$ vs UGS.
[b] $p < 0.05$ vs GRIP.
[c] $p < 0.05$ vs PEG.
[d] $p < 0.05$ vs FR.
[e] $p < 0.05$ vs BS.
* Range 0.5–1.0. Degree of discrimination: 0.7–0.8 acceptable, 0.8–0.9 excellent, 0.9–1.0 outstanding.

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encouraged in routine assessment of functional limitation and disability, including assessment of UE limitation.

Although we should consider a statistically significant difference as meaningful when comparing AUCs, Guralnik et al. (2000) have concluded that a 3–5% difference between AUCs is negligible. Furthermore, since the 95% confidence intervals largely overlapped in our study, we consider the 4–5% difference in the AUCs between UGS alone and GRIP + PEG or GRIP + PEG + FR to be insubstantial.

Onder et al. (2005) demonstrated that LEP measures, particularly UGS, showed a greater predictive ability than UEP measures for incident disability outcomes including upper extremity disability. Therefore, the UGS is considered a general measure of health and physical performance, and not just a specific indicator of localized poor function.

This is consistent with our findings, and we also showed that when combining UEP measures, the discriminating power for UE limitation did not increase meaningfully compared to UGS alone. These results would discourage the use of PEG, FR, BS, and BEAN in clinical practice and reinforce using UGS as the preferred performance measure, even more than a combination of UEP measure for assessing physical function.

Guralnik et al. (2000) showed that UGS alone, which is part of the SPPB, performed almost as well as the full SPPB in predicting incident disability. Onder et al. (2005) also demonstrated that UGS is nearly as good as their lower-extremity summary performance score in predicting incident disability. Moreover, Viccaro et al. (2011) recently evaluated the predictive ability of UGS and timed up-and-go for adverse-health outcomes. The UGS and timed up-and-go predicted outcomes equally well, but combining the two measures did not add to the predictive ability. These results also showed that, even when combining LEP measures, predictive ability does not substantially increase over UGS alone. The performance measure (e.g., GRIP and UGS), which has the strongest impact on discerning disablement, may include the vast majority of information generally obtained through the other performance measures.

In the present study, only GRIP could discriminate each functional status almost as well as UGS among individual UEP measures. There are several explanations for this. Numerous studies have consistently demonstrated that GRIP is an independent predictor of frailty (Sayer et al., 2006), disability (Rantanen et al., 1999), and cause-specific and total mortality (Rantanen et al., 2003). Thus, GRIP is also considered representative of a person's general health condition. On the other hand, Onder et al. (2005) showed that GRIP is a very specific predictor of future incident progressive upper extremity disability. Rantanen et al. (1999) also found that the GRIP test performed in middle age predicts functional limitation in terms of UE tasks 25 years later in old age. As shown by these studies, GRIP may be clinically meaningful as an indicator for both disablement and primary upper extremity function (using fingers to grasp or manipulate).

Although the importance of both UGS and GRIP as screening measures is confirmed, UGS may have greater value than GRIP. As shown in the present study, UGS can discriminate UE limitation almost as well as combined UEP measures. On the other hand, our previous study results (Seino et al., 2011) demonstrated that the discriminating power of GRIP for mobility limitation was 15% lower than the discriminating power of combined LEP measures in older women, indicating that the difference in discriminating power between the two methods was substantial. Moreover, a systematic review and meta-analysis (Cooper et al., 2011) showed that associations between physical performance measures and all-cause mortality in community-dwelling older adults. The summary hazard ratios for mortality, when comparing the best 25% with the worst 25% of performance measures, were 2.87 for UGS (five studies, 14,692 participants), and 1.67 for GRIP (14 studies, 53,476 participants). These studies indicate that the UGS is certainly more important than GRIP in the routine assessment of older adults.

There were several limitations in this study. First, population studies of older adults may sometimes be affected by a selection bias, because relatively healthier people tend to participate. Second, this study was a cross-sectional study, which does not allow evaluation of the predictive ability of the UEP measures and the combinations we studied. Moreover, we could not obtain more direct and clinically meaningful results (e.g., hazard ratio) in terms of the strength of the different combinations of UEP measures because our study design and the small sample size of participants did not permit this. Further research is needed to confirm the predictive validity of our findings in longitudinal studies. Third, although we were able to adjust our analyses for health information with this study, there could be unmeasured confounders for which we could not adjust. Finally, although we reinforced the importance of UGS and GRIP as performance measures, exercise interventions may have a differential impact on different regions and should be monitored with appropriate regional measures.

In conclusion, the results of the present study showed that, in our attempt to refine our ability to discern UE limitation and disability, the advantages of combining UEP measures were less than we expected. Our results suggest that UGS alone or GRIP alone have similar utility, and they may be adequate for assessing UE limitation and disability. In particular, UGS should be considered the first choice of performance measures, certainly more than GRIP, in routine assessment of functional limitation and disability among older women because the UGS test can discriminate UE limitation almost as well as a combination of different UEP measures.

Conflict of interest statement

None.

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原　著

高齢女性における高次生活機能の階層性と強度別身体活動量との関連
－地域支援事業参加者を対象とした横断研究－

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Cross-sectional analysis of hierarchy of higher-level functional capacity and quantity/intensity of physical activity in older women

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Abstract The purpose of this study was to examine the association between the hierarchy of higher-level functional capacity (instrumental self-competence, intellectual activity, social role) and the quantity of physical activity in older women (n = 175, 72.1 ± 5.8 years). Physical activity was estimated with a uniaxial accelerometer that calculated light-intensity physical activity (LPA), and moderate-to vigorous-intensity physical activity (MVPA). Higher-level functional capacity was assessed with the Tokyo Metropolitan Institute of Gerontology (TMIG) index of competence. According to the three subscales (instrumental self-competence, intellectual activity, and social role) of the TMIG index, participants who reported a score of 1 or more below the respective full marks were categorized as a group with reduced status. Logistic regression analysis was conducted to examine association between the hierarchy of higher-level functional capacity and the quantity of physical activity divided by intensity of activity, adjusted by covariance. Only low MVPA showed a significantly lower odds ratio than high MVPA in reduced status of instrumental self-competence. Since instrumental self-competence was significantly related with only the quantity of MVPA, it may be more important to focus on "quantity" of physical activity to prevent reductions in higher-level functional capacity in advanced stages of declining functional capacity.

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Keywords : older women, physical activity assessed by the uniaxial accelerometer, the hierarchy of high-level functional capacity

緒　言

高齢期における健康目標は，単に疾病がないことや余命の延伸にとどまらず，時には疾病を保持しながらも生活機能の自立期間を可能な限り保持することにある[1)]．ここでいう生活機能とは，基本的日常生活動作能力から社会的役割までの様々な水準の機能を含んでいる．Fujiwara et al.[2,3)]は，加齢に伴う生活機能の低下を8年間追跡し，一般的な地域在住高齢者では，社会的役割，知的能動性，手段的日常生活動作能力，基本的日常生活動作能力の順で，高次な機能から低下すると報告している（生活機能低下の階層性）．社会的役割・知的能動性の低下を認めてから基本的日常生活動作能力の低下を認めるには，平均で約10年のタイムラグがあることから，基本的日常生活動作能力の低下は，高次生活機能の低下を抑制することで理論的には抑制可能であると考えられる[4)]．

高次生活機能の低下には，人口統計学的要因，身体的要因，心理的要因，ライフスタイル要因が関連している[5-7)]．ライフスタイルは可変的な要因であることから，

運動や栄養に着目した研究や介護予防策が，積極的に展開されてきた[8-11]．とりわけ定期的な運動実践が，高齢期の身体機能に及ぼす影響は大きく[12]，有酸素性運動やレジスタンス運動，バランス運動，柔軟性運動の身体機能に及ぼす有効性が明らかにされてきた[13]．また近年，家事や仕事といった生活活動，あるいは3metabolic equivalents（METs）未満の低強度活動でも，高齢期の身体機能に良好な影響を及ぼすことが報告されている[14-15]．したがって，運動量だけでなく，生活活動量や低強度活動量の多寡についても，高齢期の高次生活機能に影響を及ぼしている可能性があると考えられる．

高齢期の身体活動量と心身機能の関連性を検討した研究[16-20]は比較的多い一方で，身体活動量と高次生活機能の関連性を検討した研究は少なく，われわれが知るところ1件のみである．田中ら[21]は，地域に在住する高齢者330人を対象に，質問紙によって評価された身体活動レベル（physical activity level: PAL）と高次生活機能の関連性を検討している．その結果，PALが低値である者は，知的能動性および社会的役割が低下状態にあると報告されている．しかし，1）身体活動量の評価に質問紙を利用しており，客観的な評価指標である加速度計を用いて検討していないこと，2）高次生活機能の階層性と強度別身体活動量の関連性を検討していないといった課題を有している．これまで，ボランティア活動など社会的役割を担う活動が高次生活機能を維持するうえで有効であることが報告されており[22-26]，活動の「質」が着目されてきた．その一方で，日常生活における活動の単純な「量」が高次生活機能に影響するかどうかは明らかではなく，活動量を客観的に評価することが可能な加速度計を用いて関連性を検討することが望ましい．また，我が国の高齢女性の場合，年齢と負の関連がある身体活動量は，中高強度活動量（moderate-to vigorous-intensity physical activity: MVPA）ではなく低強度活動量（light-intensity physical activity: LPA）であると報告されている[27]．さらに，新開ら[28]は，一日のエネルギー消費量を従属変数，各活動（睡眠・不活動的余暇・家事・歩行/自転車・活動的余暇・仕事・運動）のエネルギー消費量を目的変数としたステップワイズ法による重回帰分析をおこなったところ，女性では「家事」と「活動的余暇」の二つで一日のエネルギー消費量の全分散の56%が説明されたと報告している．したがって，本邦の高齢女性の場合，家事や余暇活動などの比較的強度が低い活動すなわちLPAの多寡が高次生活機能の低下状態に関連すると考えられる．また，高次生活機能は，加齢に伴い高次な機能（社会的役割，知的能動性，手段的自立）から階層的に低下するが[2-3]，これら3つの階層と強度別身体活動量の多寡との関連性を検討した研究は見当たらない．前述した課題を検討するため，本研究では一軸加速度計を用いて，高次生活機能の階層性と強度別身体活動量の多寡との関連性を横断的に検討することを目的とした．

介護予防事業の最終目標は，生活機能の低下を可能な限り抑制し，自己実現と生きがいを創出することである[11]．特に女性は，男性に比べ高次生活機能の低下度が大きく[6]，また様々な機能に障害を抱える期間が長い[29]．高齢女性における高次生活機能の階層性と強度別身体活動量との関連性が明らかになることで，生活機能の低下度に応じた強度別身体活動の「量」そのものの有効性がさらに明確になると考えられる．

方　法

対象者

対象者は，要支援・要介護の非認定者で，2009～2011年の茨城県八千代町の二次予防事業と茨城県阿見町，千葉県袖ケ浦市の一次予防事業に参加した60歳以上の高齢女性208名とした．各自治体の広報誌やチラシ，自治体職員による参加推奨などを通して募集し，本人の意思で参加した．対象者のうち，1）体力測定時に杖や他者の補助を必要とした者（4名），2）質問紙や一軸加速度計のデータに欠損のあった者（29名）を除外し，最終的に175名（72.1±5.8歳，二次予防事業参加者51名（77.3±5.5歳），一次予防事業参加者124名（70.0±4.4歳））を解析対象とした．すべての対象者に，研究の目的や身体活動量・身体機能測定および質問紙調査の内容を十分に説明し，全員から研究協力への同意を得た．また，本研究は，筑波大学大学院人間総合科学研究科に帰属する倫理委員会の承認を受けた．

測定項目および測定方法

形態

形態指標として，身長は身長計（YG-200，ヤガミ社製）を用いて0.1cm単位で，体重は体重計（Digital Bathroom Scale HD-316，TANITA社製）を用いて0.1kg単位で測定した．Body mass index (BMI) は，体重 (kg) を身長 (m) の2乗で除すことにより算出した．

身体活動量

身体活動量は，一軸加速度計（Lifecorder，スズケン社製）を用いて評価し，1日あたりの歩数（step counts: SC）とLPAおよびMVPAの活動時間を算出した．1軸加速度計の妥当性および信頼性については，先行研究により確認されている[30]．測定期間は，配布日の翌日から7日間とし，入浴および入水時以外の起床から就寝まで装着するよう求めた．装着部位は，身体の前面・腰部とし，ベルトまたはズボンの裾をクリップで挟み装着するよう教示した．解析対象者は，5日/週以上の装着期間かつ8時間/日以上の装着時間の条件を満たす者と

した[31,32]．また，SC，LPA，MVPAを2分位に群分けし，それぞれ低値群と高値群に設定した．

高次生活機能

高次生活機能は，老研式活動能力指標を用いて評価した[33]．「はい（1点）」，「いいえ（0点）」の2件法で回答する13の質問項目から，総得点（13点）と下位尺度得点（手段的自立5点，知的能動性4点，社会的役割4点）を算出した．本研究では，総得点および下位尺度得点の未満点者を「生活機能低下状態群」，満点者を「生活機能維持群」と定義した[2,3,21,34,35]．

身体機能

身体機能は，4つの測定項目（握力，5m通常歩行，開眼片足立ち，5回いす立ち上がり）により評価した．これらの測定項目は，高い信頼性，簡便性を有しており，我が国の地域支援事業（運動器の機能向上）におけるスクリーニング評価項目に含まれている[11]．また，これらの測定値は，骨折や認知機能低下，循環器疾患発症，入院，施設入所，総死亡などの予測指標となりうることが報告されている[36,37]．したがって，上述した4つの測定項目は，高齢期における高次生活機能の低下や身体活動量の減少を如実に反映する有用な指標であると考えられるため，それら4つの測定項目から身体機能を評価することとした．各項目の測定方法は，下記の通りである．

握力

スメドレー式握力計（GRIP－D，T.K.K5401，竹井機器工業社製）を手に持ち，両腕を体側で自然に下げ，リラックスした姿勢をとるよう求めた．握り幅は，対象者が握りやすいよう調整し，持ち手は身体に触れないように，かつ大きく動かさないように教示した．次に，呼息しながら握力計を可能な限り強く握るよう教示した．0.1kg単位で左右交互に2回ずつ計測し，平均値を記録とした．

5m通常歩行

5mの歩行路を通常の歩く速さで歩いた時間を0.01秒単位で2回測定し，平均値を記録した．歩行路の両端には1mの予備路を設けた．

開眼片足立ち

両手を腰に当て，両足を揃えて床の上に立った状態から片方の足を床から離し，可能な限り長く立ち続けるよう求めた．接地している支持足の裏が動いたり，腰に当てた手が離れたり，支持足以外の身体部分が着地した時点でバランスが崩れたものとみなした．計測は，足を上げた時点からバランスが崩れた時点までの時間とし，最大値は60秒とした．左右を問わず0.01秒単位で2回計測し，平均値を記録とした．

5回いす立ち上がり

両腕を胸の前で交差し，背中を伸ばした状態で背もたれのついたいすに浅く腰かけるよう求めた．合図とともに，いすから立ち上がり直立姿勢をとり，再びいすに腰掛ける動作を可能な限り速く5回繰り返すよう教示した．合図してから5回目の直立姿勢をとるまでの時間を0.01秒単位で2回計測し，平均値を記録とした．

測定の際は，問診によって当日の体調を確認するとともに，体力測定に精通したスタッフが安全性に十分に留意した．また，測定で補助や支えを必要とした場合はその旨を記録した．

質問紙調査

交絡要因として報告されている喫煙，飲酒，独居，慢性疾患（脳血管疾患，高血圧，糖尿病，心疾患，骨粗鬆症，呼吸器疾患），関節痛（膝痛，腰痛）の有無，服薬状況などの健康関連情報をインタビュー形式で聴取した[38]．なお，服薬状況は，現在服用している薬の数を聴取した．薬は，医師から処方された医療用医薬品とし，薬局等で購入した一般用医薬品や医薬部外品，サプリメントは除外するものとした．

統計解析

各項目の測定結果は，平均値±標準偏差で示した．生活機能低下状態群と生活機能維持群の健康関連情報，形態指標の比較には，対応のないt検定またはMann-WhitneyのU検定を適用した．疾患や関節痛を有する者の割合は，χ^2検定によって比較した．身体活動量（SC，LPA，MVPA）の比較は，年齢と骨粗鬆症・腰痛・膝痛の有無を共変量にした共分散分析を適用し，有意差が認められた場合，post hoc testとしてBonferroni法による多重比較検定をおこなった．高次生活機能の階層性と強度別身体活動量との関連性を検討するために，ロジスティック回帰分析を適用し，高次生活機能および各下位尺度機能低下状態（手段的自立低下，知的能動性低下，社会的役割低下）に対するSC・LPA・MVPA高値群を基準としたSC・LPA・MVPA低値群のオッズ比を，年齢，骨粗鬆症・腰痛・膝痛の有無で調整して求めた．また，身体機能4項目をLPAおよびMVPAの低値群と高値群で比較するために，年齢，骨粗鬆症・腰痛・膝痛の有無を共変量にした共分散分析を適用し，有意差が認められた場合，post hoc testとしてBonferroni法による多重比較検定をおこなった．すべての統計処理にはSPSS17.0J for Windowsを用い，統計的有意水準は5％とした．

結果

Table 1に，生活機能低下状態群と生活機能維持群で比較した対象者の基本的特徴を統計値で示した．年齢，身長，骨粗鬆症，腰痛・膝痛の有無の項目で有意な群間差がみられた．

Table 2に，各機能低下状態に対するSC・LPA・

Table 1. Characteristics of the study participants, prevalence (%) or mean ± SD

Characteristics	All participants n = 175	Group reduction n = 81	Group maintain n = 94
Age, yr	73.2 ± 5.8	74.4 ± 5.7	71.1 ± 5.0*
Height, cm	147.9 ± 5.5	146.5 ± 5.4	149.0 ± 5.7*
Weight, kg	52.3 ± 8.1	51.5 ± 7.6	52.6 ± 8.6
Body mass index, kg/m^2	23.9 ± 3.5	24.0 ± 3.4	23.7 ± 3.6
Number of medications	2.0 ± 2.2	2.3 ± 2.0	1.4 ± 2.0
Medical history in 1 year			
Stroke, yes	1.7	2.5	1.1
Hypertension, yes	40.6	39.5	41.5
Diabetes, yes	6.9	4.9	8.5
Heart disease, yes	5.7	7.4	4.3
Osteoporosis, yes	8.0	14.8	2.1*
Respiratory disease, yes	3.0	4.1	2.0
Joint pain			
Low back pain, yes	29.7	42.0	19.1*
Knee pain, yes	26.9	37.0	18.1*
Living alone, yes	16.0	17.3	14.9
Smoking, yes	5.1	6.2	4.3
Drinking, yes	18.3	18.5	18.1
Physical activity, mean ± SE			
Step count, steps/day	7187 ± 3019	7017 ± 309	7333 ± 285
LPA, min/day	58.3 ± 22.9	57.4 ± 2.5	59.1 ± 2.3
MVPA, min/day	17.9 ± 14.5	17.7 ± 1.5	18.2 ± 1.4

SD = standard deviation; SE = standard error; LPA = light intensity physical activity
MVPA = moderate-to vigorous-intensity physical activity
* $P < 0.05$ vs Group reduction

Table 2. Odds ratio and 95% CI for reduction in higher-level functional capacity according to the quantity of physical activity.

Physical activity	Adjusted† odds ratio (95% CI) and *P* value							
	Reduce in instrumental self-maintenance		Reduce in intellectual activity		Reduce in social role		Reduce in total score	
	Odds ratio (95% CI)	*P*	Odds ratio (95% CI)	*P*	Odds ratio (95% CI)	*P*	Odds ratio (95% CI)	*P*
Step count								
High-SC (> 7133 count/day)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Low-SC (≤ 7133 count/day)	1.99 (0.53-7.54)	0.31	0.96 (0.43-2.15)	0.93	1.54 (0.77-3.07)	0.22	1.32 (0.65-2.66)	0.44
Light intensity physical activity								
High-LPA (> 55.4 min/day)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Low-LPA (≤ 55.4 min/day)	1.77 (0.56-5.65)	0.33	1.31(0.61-2.81)	0.50	1.07 (0.55-2.07)	0.85	1.10(0.55-2.18)	0.79
Moderate-to vigorous-intensity physical activity								
High-MVPA (> 15.4 min/day)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Low-MVPA (≤ 15.4 min/day)	5.03 (1.01-24.99)	$P < 0.05$	0.62 (0.27-1.42)	0.26	1.10 (0.55-2.21)	0.78	0.92 (0.45-1.88)	0.81

CI: confidence interval; LPA = light intensity physical activity; MVPA = moderate-to vigorous-intensity physical activity
†: Adjusted for age, osteoporosis, lowback pain, knee pain.

Table 3. Camparision of physical function according to the level of LPA and MVPA, mean ± SE

Physical function	Low LPA ≤ 55.4 min/day n = 87	High LPA > 55.4 min/day n = 88	Low MVPA ≤ 15.4 min/day n = 87	High MVPA > 15.4 min/day n = 88
Hand grip strength, kg	20.8 ± 0.4	21.4 ± 0.4	21.1 ± 0.4	21.1 ± 0.4
5-m habitual walk, s	4.2 ± 0.1	4.1 ± 0.1	4.4 ± 0.1	4.0 ± 0.1*
5-chair sit-to-stand, s	7.5 ± 0.3	7.7 ± 0.3	8.1 ± 0.3	7.1 ± 0.3*
One leg balance, s	35.6 ± 2.1	35.6 ± 2.1	32.7 ± 2.2	38.5 ± 2.1

SE = standard error; LPA = light intensity physical activity; MVPA = moderate-to vigorous-intensity physical activity
*: $P < 0.05$ vs group low

MVPA高値群を基準としたSC・LPA・MVPA低値群の調整済みオッズ比（95% CI）を示した．手段的自立低下状態に対するSC・LPA・MVPA高値群を基準としたSC・LPA・MVPA低値群のオッズ比は，それぞれ1.99（0.53-7.54），1.77（0.56-5.65），5.03（1.01-24.99），知的能動性低下状態は0.96（0.43-2.15），1.31（0.61-2.81），0.62（0.27-1.42），社会的役割低下状態は1.54（0.77-3.07），1.07（0.55-2.07），1.10（0.55-2.21），高次生活機能（総合得点）低下状態は1.32（0.65-2.66），1.10（0.55-2.18），0.92（0.45-1.88）であった．

Table 3に，各身体機能測定値をLPAおよびMVPAの低値群と高値群で比較した結果を示した．各身体機能測定値をLPA低値群と高値群で比較した結果，すべての群間に有意な差はみられなかった．各身体機能測定値をMVPA低値群と高値群で比較した結果，5m通常歩行と5回いす立ち上がりに，有意な群間差がみられた．

考　察

本研究では，一軸加速度計により評価された強度別身体活動量（SC, LPA, MVPA）の多寡と高次生活機能の階層性との関連性を検討した．その結果，強度別身体活動量の多寡と全体的な高次生活機能低下状態に有意な関連性はみられなかったが，高次生活機能のなかで最も低次な機能である手段的自立は，MVPAの多寡と有意な関連性がみられた．

客観的に評価された身体活動量と高次生活機能の関連性

SC, LPA, MVPAが低値であっても，高次生活機能低下（総合得点未満点者）に対するオッズ比は有意に高値ではなかったことから，客観的に評価された身体活動量と高次生活機能は関連しないと考えられる．

田中ら[21]は，330名の地域在住高齢者を対象に，質問紙によって評価されたPALと高次生活機能の関連性を検討している．独立変数を高次生活機能3群（13点・12点・11点以下），従属変数をPALとし，年齢・性を共変量とした共分散分析をおこなった結果，知的能動性得点，社会的役割得点，総合得点において有意な群間差が得られたと報告している．本研究でも先行研究と同様の群分け・分析方法で検討を試みたが，すべての高次生活機能項目において，身体活動量に有意な群間差はみられなかった．地域で自立した生活を営む高齢者においては，客観的に評価された身体活動量と老研式活動能力指標によって評価された高次生活機能は必ずしも関連するとはいえない可能性が示唆された．

その要因としては，以下の2点があげられる．第1に，高次生活機能には，身体（歩行）活動の「量」だけでなく，「活動範囲」が関連していると考えられる． 新開ら[39]やFujita et al.[40]は，移動能力が保たれている高齢者であっても，行動範囲が「閉じこもり」と定義されるほど極めて狭ければ，年齢の影響を調整しても基本的日常生活動作能力や手段的日常生活能力の障害発生に影響を及ぼすと報告している．移動能力や活動量が保持されていても，その活動範囲が狭ければ，高次生活機能に良好な影響を及ぼさない可能性がある．第2に，高次生活機能の低下には，身体活動の「量」そのものよりも，身体活動の「内容」が関連していると考えられる．先行研究によると，高齢者に絵本の読み聞かせ役や介護予防推進ボランティア活動などの社会参加の機会を提供したところ，高次生活機能の低下抑制が認められたと報告されている[22-26]．活動量が多くても，その活動内容に社会的・知的活動が含まれていなければ，高次生活機能に良好な影響を及ぼさない可能性がある．本研究では，一軸加速度計を用いて身体活動量を評価したため，身体活動の「量」を評価するという点では，質問紙に比べ妥当性や信頼性が高いと考えられるが，「活動範囲」や「活動内容」など，活動の「質」そのものを評価するには限界を有する．一方で田中ら[21]は，質問紙を用いて身体活動量を評価しており，単純な活動量だけではなく，高次生活機能と関連がある家事・仕事など活動の内容をよく反映していると考えられる．客観的に評価された身体活動量と高次生活機能の関連性がみられなかった本研究結果は，身体活動量の評価方法の差異という観点から鑑みると，妥当な結果であると考えられる．高次生活機能の低下抑制には，活動量のみに着目するのではなく，活動範囲を可能な限り幅広く設け，知的・社会的刺激が伴う活動量を確保していくことも重要である可能性が示唆された．

高次生活機能の階層性と強度別身体活動量との関連性

本研究は，LPAの多寡が高次生活機能と関連するという仮説を設定した．ロジスティック回帰分析を用いて仮説の検証をおこなったところ，各機能低下状態に対するLPA低値群のオッズ比は，LPA高値群に比べ有意に高値でなかったことから，本研究の仮説は棄却される結果となった．一方で，各機能低下に対するMVPA高値群を基準としたMVPA低値群のオッズ比は，手段的自立低下状態のみ，MVPA高値群に比べて約5倍高値であった．これらの結果から，身体活動の「量」そのものは，高次な機能（社会的役割・知的能動性）とは関連しないが，機能が低次に移行する（手段的自立）ことで関連する可能性が示唆された．また，高次な機能である社会的役割・知的能動性は身体活動量の強度に影響されないが，低次な機能である手段的自立は身体活動の強度に影響される可能性が示唆された．

LPA低値群と高値群で各身体機能測定値を比較した結果，すべての項目において有意差はみられなかった．一方で，MVPA低値群と高値群で各身体機能測定値を比較した結果，5m通常歩行および5回いす立ち上がりに有意差がみられたことから，LPAの多寡は，高齢女性の身体機能と関連しないが，MVPAの多寡は高齢女性の歩行能力・下肢筋力に影響を及ぼす可能性が示唆された．歩行能力や下肢筋力は，高齢者の移動能力を構成する主要な身体機能の一つである[41]ため，MVPAを多く確保している者は，移動能力を高く保持することで，手段的自立の低下を結果的に抑制している可能性がある．言い換えれば，MVPAを可能な限り多く確保することで，歩行能力や下肢の筋力など移動能力に関連する

身体機能が良好に維持され，バスなどの交通機関の利用，買い物，銀行預金の出し入れなど，高齢者にとって比較的難易度の高い活動が保持できると考えられる．手段的自立低下の抑制には，LPAよりもMVPAを確保することが重要なのかもしれない．一方で，社会的役割・知的能動性は身体活動の「量」と関連しなかったことから，高次生活機能の低下をより早期に抑制するには，身体活動の「量」ではなく，社会的・知的活動といった活動の「質」を重視した予防策を講じる必要があると考えられる．

研究の限界および今後の課題

本研究はいくつかの限界を有する．第1に，対象者は3つの自治体で開催された地域支援事業に参加した住民であり，二次予防事業参加者は51名（29.1%）含まれていた．本邦における二次予防事業候補者は65歳以上の高齢者の約7.1%程度であることが報告されているため[42]，本研究標本は，高次生活機能の低下した参加者が比較的多いと考えられる．また，握力値も全国の同年代の平均値（65-69歳: 24.6±3.9 kg, 70-74歳: 23.4±4.1 kg, 75-79歳: 21.9±4.2 kg）[43]と比較して，本研究対象者で低値（65-69歳: 22.1±3.9 kg, 70-74歳: 21.6±3.0 kg, 75-79歳: 19.9±4.0 kg）であったことから，本研究で得られた結果が，必ずしも幅広い地域やライフスタイルの異なる集団にも適用されるとは限らない．第2に，本研究で用いた一軸加速度計は，三軸加速度計と比較して，高齢者に多いLPAを過小評価すると報告されているため[44]，今後は三軸加速度計を用いてLPAを推量し，高次生活機能との関連性を検討する必要がある．また，加速度計は身体活動量の客観的な評価指標としては有用な測定器であるが，水中での身体活動や自転車による身体活動量が評価されていないことに加え，測定期間内における天候や季節の影響，傾斜地での歩行活動が考慮されていないため，必ずしも，1日あたりの活動量を精確に網羅しているとは限らない．第3に，本研究は横断研究であるため，過去の縦断研究より因果関係を推論することは可能であるが，証明するにはいたらない．したがって，今後は無作為抽出によって大規模に対象者を選定し，身体活動量の減少と生活機能の低下との関連性を縦断的な観点から検討する必要がある．また，三軸加速度計で補うことができない活動量（自転車運動や水中運動）や天候などの影響を質問紙調査によって把握していく必要がある．

結　語

LPAおよびMVPAが少なくても，高次生活機能低下状態に対するオッズ比は有意に高値でないことから，地域で自立した生活を営む高齢女性においては，客観的に評価された強度別身体活動量と高次生活機能は関連しない可能性が示唆された．一方で，機能低下の進行過程に着目すると，最も低次な機能（手段的自立）のみMVPAの多寡が有意に関連したことから，機能低下が進んでいない段階では身体活動の「量」そのもの以外に注視した予防策が必要であるが，機能低下が進んだ状態では「量」そのもの，特にMVPAに注視した予防策を講じることの重要性が示唆された．

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身体的虚弱が疑われる低体力と運動量の関係：地域在住高齢女性を対象とした横断研究

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Abstract：PURPOSE: The purpose of this study was to examine the association between low fitness status and quantity of exercise, and to derive a reference value of exercise for preventing low fitness status, in community-dwelling older women.
METHODS: The participants were 515 community-dwelling older women, aged 65 to 91 years (73.4 ± 5.5 years). Physical fitness was assessed using a functional fitness score (FFS), which was calculated from the scores of four fitness items (i.e., tandem stance, 5-chair sit-to-stand, alternate step, and up & go). The quantity of exercise (QE) was calculated by multiplying exercise duration, exercise frequency and exercise intensity per week. The participants were divided into four groups according to the level of QE (no exercise: NE Group (QE = 0), Low Tertile Group (0 < QE ≦ 4.6), Middle Tertile Group (4.6 < QE ≦ 11.7), High Tertile Group (QE > 11.7)). FFSs of less than 0.065 were defined as the low fitness, and those of 0.065 or more were defined as good fitness. Logistic regression analysis was performed to obtain odds ratios (ORs) and 95% confidence interval (CI) for the low fitness according to the level of QE. Receiver operating characteristic (ROC) analysis was conducted to detect a reference value of QE.
RESULTS: The ORs (95% CI) compared with the NE Group were 0.76 (0.44–1.32) in the Low Group, 0.53 (0.31–0.92) in the Middle Group, and 0.30 (0.17–0.55) in the High Group. The optimal QE cut-off value for the low fitness was 5.1 METs·hour/week (area under the ROC curve: 0.64, sensitivity: 55%, specificity: 68%).
CONCLUSION: It is recommended that community-dwelling older women exceed at least 5.1 METs·hour/week on a regular basis to prevent the low fitness status. Longitudinal research on the quantity of exercise, assessed using an accelerometer, is needed to obtain a more accurate reference value.

Key words：older women, low fitness, quantity of exercise, reference value
キーワード：高齢女性，低体力，運動量，基準値

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I　緒　　言

我が国の平均寿命および健康寿命は，世界最高水準まで到達したにもかかわらず，依然として男性は約6年間，女性は約8年間の非自立期間（健康寿命—平均寿命）を要すると報告されている（総務省，2007）．平均寿命および健康寿命が飛躍的に伸びた今，非自立期間を短縮し，高齢期における自己実現の達成や QoL（quality of life）を良好に維持していくことが重要である（田中ほか，2004）．高齢者が自立した生活を営む上で必要な能力，すなわち交通機関の利用や階段昇降，食事，清掃などを遂行する能力の低下には，身体の虚弱化が密接に関連すると報告されている（Fried et al., 2001）．そして身体の虚弱化は，筋力やバランス能力といった体力の低下から生じると報告されている（Guralnik et al., 1994）．

加齢による体力の低下は不可避的な現象であるが，成人期から運動を定期的に実践することで，体力の低下は抑制可能である（Gauchard et al., 2003）．厚生労働省は「健康づくりのための運動基準2006」を策定し，健康づくりに必要な身体活動量・運動量として中強度（3メッツ）以上の身体活動および運動を，それぞれ23メッツ・時/週，4メッツ・時/週，実践することを基準値として定めた．また，健康の維持・増進に必要な体力の基準値として，年齢階級・性別に最大酸素摂取量の基準値が定められており，日本国民の健康づくりに有用な指針として活用されることが期待されている（厚生労働省，2006）．

しかし，「健康づくりのための運動基準2006」の基準値は，性や年齢階級別に基準値を設定するにはエビデンスが不十分であり，未成年者や高齢者を対象とした基準値の策定が望まれている（田中，2006）．さらに，基準値の設定にあたり，日本人を対象とした研究は84件中8本の引用に留まっているため，より多くの日本人を対象とした身体活動・運動に関する疫学的な研究が切望されている（村上・宮地，2010）．このような背景から，我が国の高齢期における至適運動量についての検討は不十分な実情にある（Aoyagi and Shephard, 2010）．地域在住高齢女性の体力の低下予防に着目した運動量の水準を検討することは，今後高齢期における非自立期間の短縮に焦点をあてた運動指針を作成するにあたり，有益な知見の1つになると考えられる．

そこで本研究では，地域在住高齢女性の運動習慣と体力レベルを詳細に調査したデータを用いて，身体的虚弱が疑われる低体力と運動量の関係を横断的に分析し，体力の低下予防に推奨される運動量の基準値を検討した．

II　方　　法

A.　対象者

対象者は，2008–2010年に茨城県阿見町，下妻市，八千代町，千葉県袖ケ浦市，福島県会津美里町での地域支援事業または体力測定会に参加した65–91歳の高齢女性のうち，1)医師から認知症の診断を受けていない，2)介護認定を受けていない，636名とした．対象者のうち，1)杖や支えなどの補助器具を必要とし，自力での体力測定が困難であった者（15名），2)問診時に脳血管疾患やパーキンソン病，リウマチなどの神経性疾患の既往があった者（15名），3)データに欠損のあった者（63名），4)実践している運動のメッツが不明であった者（28名）を除外し，最終的に515名を分析対象者とした．

対象者の募集は，各自治体の広報誌やチラシ，自治体職員による参加奨励などを通しておこなった．すべての対象者に研究の目的や体力測定および質問紙調査内容を説明し，随時，測定を拒否できることを説明した．研究での測定データ使用に関する説明を個別に口頭でおこない，書面にてデータ使用の同意を得た．本研究は，筑波大学大学院人間総合科学研究科倫理委員会の承認を受けている．

B.　測定項目および測定方法

1.　基本情報および健康関連情報

形態指標として，身長は身長計（YG-200，ヤ