healthcare

MDPI

Article

The Association between Health Literacy and Gait Speed in Community-Dwelling Older Adults

Kunihiko Anami [1,*], Shin Murata [2], Hideki Nakano [2], Koji Nonaka [1], Hiroaki Iwase [3], Kayoko Shiraiwa [2], Teppei Abiko [2], Akio Goda [2] and Jun Horie [2]

[1] Department of Rehabilitation, Faculty of Health Sciences, Naragakuen University, Nara 631-8524, Japan; anami@naragakuen-u.jp (K.A.); nonaka@naragakuen-u.jp (K.N.)
[2] Department of Physical Therapy, Faculty of Health Sciences, Kyoto Tachibana University, Kyoto 607-8175 Japan; murata-s@tachibana-u.ac.jp (S.M.); nakano-h@tachibana-u.ac.jp (H.N.); shiraiwa@tachibana-u.ac.jp (K.S.); abiko@tachibana-u.ac.jp (T.A.); goda@tachibana-u.ac.jp (A.G.); horie-j@tachibana-u.ac.jp (J.H.)
[3] Department of Physical Therapy, Faculty of Rehabilitation, Kobe International University, Kobe 658-0032, Japan; iwase@kobe-kiu.ac.jp (H.I.)
* Correspondence: anami@naragakuen-u.jp; Tel.: +81-742-93-5427

Received: date; Accepted: date; Published: date

Abstract: The association between gait speed, a vital health outcome in older adults, and health literacy, an important health promotion aspect, is unclear. This study examined the relationship of gait speed with health literacy, physical function, and cognitive function in community-dwelling older adults. Subjects were 255 older adults (54 men, mean age 74.0±6.2 years). Gender, age, and education history were self-reported while height and weight were measured directly. Health literacy was evaluated using Communicative and Critical Health Literacy (CCHL). Grip strength, knee extension strength, toe-grip strength, sit-up repetitions, sit-and-reach, one-leg stance test time, 30-second chair-stand test (CS-30), and normal gait speed were measured. Subjects were divided into two groups based on normal gait speed—fast (speed≥1.3m/s) and slow (<1.3m/s). Between-group differences were analyzed using independent t-tests and chi-squared tests. In the logistic regression analysis, dependent variable was normal gait speed (fast/slow) and independent variables were indicators with significant differences, namely, height, CCHL, grip strength, knee extension strength, toe-grip strength, sit-and-reach, one-leg stance test time, and CS-30. Height, CCHL, and CS-30 were found to independently affect gait speed. That health literacy influences gait speed is new discovery. Health promotion activities should incorporate health literacy in maintaining gait speed.

Keywords: health literacy; gait speed; physical function; cognitive function; community-dwelling older adults

1. Introduction

As Japan faces a super-aged society never before experienced in human history, a variety of health outcomes are being evaluated both in communities and in hospitals by industrial, government, and academic sectors to understand the extent of disabilities and to enable disease prevention and long-term care prevention. Among these health outcomes, gait speed [1-3] has been identified as an extremely important indicator. Gait speed not only decreases with age [1-4] but affects both everyday activities [5] and quality of life [6-8]. Studenski et al. [3] explored gait speed and life expectancy in 34,485 community-dwelling adults aged 65 years or older with an average follow-up period of 12 years. They found that gait speed is correlated with survival rate; for each 0.1m/s increase in gait speed, the risk of mortality drops by roughly 10%. A separate study by Montero-Odasso et al. [9] found that slower gait speed is associated with risks such as hospitalization. Gait speed has also been

identified as a clinical indicator of the extent of disability in chronic respiratory [10-12] and cardiovascular disease [13].

The importance of gait speed is not limited to physical function. It has also been found to be correlated with cognitive function [14] and attention [15,16], which are essential for reading comprehension and have been linked to health literacy, a concept that has been drawing interest across the globe in recent years [17,18]. A systematic review by Sorensen et al. [19] summarizing existing definitions defined health literacy as "people's knowledge, motivation, and competences to access, understand, appraise, and apply health information in order to make judgments and take decisions in everyday life concerning healthcare, disease prevention, and health promotion to maintain or improve quality of life during the life course." A different systematic review by Berkman et al. [20] found that low health literacy was associated with increased hospitalizations, greater use of emergency care, and difficulty taking medications appropriately, and in older adults, it was associated with poorer overall health status and higher mortality rates. There are limited number of studies on health literacy in Japan [21-24]. The few studies that do exist have found that low health literacy is associated with low health status [22] and that health literacy is relatively low in Japan compared to European countries [23]. The authors were unable to find research discussing the correlation between health literacy and gait speed in detail among the published literature on health literacy.

Therefore, this study aimed to explore the relationship of gait speed with health literacy, physical function, and cognitive function in community-dwelling older adults.

2. Materials and Methods

2.1. Subjects

Subjects were 255 community-dwelling older adults signed up with a community older adult social exchange program who participated in the 2017 group physical fitness test. There were 54 men and 201 women with a mean age of 74.0±6.2 years. Exclusion criteria were history of central nervous system disorders including cerebrovascular disease or Parkinson's disease, difficulty in measurement due to orthopedic disorder, and cognitive impairment as judged by a Mini Mental State Examination (MMSE) score of 23 or below. All subjects consented to participation before measurement after receiving both written and oral explanation of the research objective and a summary of the study. This study was carried out with approval from the Kyoto Tachibana University research ethics committee (approval no. 17-14).

2.2. Data collection

2.2.1. Basic Attributes

Subjects were asked to report their age, gender, education history, and whether they had a history of chronic diseases (hypertension, dyslipidemia, diabetes, cardiovascular disease, respiratory disease, osteoporosis, and orthopedic disease) with a self-administered questionnaire. Height, weight, and body mass index were measured directly.

2.2.2. Gait Speed

Gait speed was measured using a digital stopwatch on an 11-m walking path designed with a 5-m measurement section bordered on either side by 3-m preparation sections. At the start of measurement, subjects were verbally instructed to "Please walk normally" and their walking time was measured. Gait speed (m/s) was calculated using the time recorded (s).

2.2.3. Health Literacy

Health literacy was assessed with the Communicative and Critical Health Literacy (CCHL), a self-administered questionnaire developed by Ishikawa et al. [21] to evaluate health literacy in

members of the general public who do not have any notable diseases. The scale score is calculated using five items. A higher score indicates higher health literacy. Generally, health literacy consists of functional literacy, higher-order interactive literacy, and critical literacy. Functional literacy refers to the ability to read and write. Interactive literacy describes the development of skills that allow independent, knowledge-based action in a supportive environment. Critical literacy is the ability to critically analyze and use information to better control everyday events and circumstances. CCHL is comprised of interactive and critical literacies.

2.2.4. Physical and Cognitive Function

Grip strength, knee extension strength, toe-grip strength, sit-up repetitions, 30-second chair-stand test (CS-30), sit-and-reach, and one-leg stance test time were measured as evaluations of physical function.

Grip strength was evaluated using a digital hand dynamometer (Takei Scientific Instruments, T.K.K. 5401 Grip-D). Two measurements were taken for each side while standing upright with the arms hanging alongside the body and without allowing the dynamometer to touch the body. The maximum observed value (kg) was used.

Knee extension strength was evaluated using a handheld dynamometer (Anima, μ-Tas F-1). Measurements were taken with the subject seated in a chair with the knees flexed at 90° and the sensor pad fixed in place with a band at the distal end of the legs. Two measurements were taken for each leg. The body weight-normalized percentage (%), calculated by dividing the maximum observed value (kgf) by body weight (kg), was used.

Toe-grip strength was evaluated using a toe-grip dynamometer (Takei Scientific Instruments, T.K.K. 3362). Measurements were taken with the subject seated in a chair with the knees flexed at 90° and the ankles halfway between plantar flexion and dorsiflexion and internal and external rotation[25]. Two measurements were taken for each foot. The maximum observed value (kg) was used.

For sit-up repetitions, Subjects were instructed to sit up from a supine position with the arms crossed over the chest and the knees flexed at 90° until the elbows touched the thighs[26]. The number of repetitions subjects could complete in 30 s was recorded.

CS-30 was measured using the method described by Jones et al. [27]. Subjects began seated in a chair (height: 40 cm) with the arms crossed over the chest. They were instructed that reaching a standing position with the knees fully straightened and then sitting once again would be considered one cycle of movement and that, at the start signal, they should repeat that cycle as many times as possible for 30 s. The number of repetitions was counted.

Sit-and-reach was evaluated using a digital sit-and-reach box (Takei Scientific Instruments). The distance covered by the finger tips during the reach was measured. Two measurements were taken and the maximum observed distance (cm) was used.

One-leg stance test time was evaluated using a digital stopwatch. The duration for which the subject could maintain a one-legged standing position with the eyes open was measured[28]. Two measurements were taken for each leg and the maximum duration (s) was used. Time for the one-leg stance test was capped at 120 s.

Cognitive function was evaluated using the MMSE and Trail Making Test-A (TMT-A). The MMSE is widely used as a general test of cognitive function. It consists of 11 items yielding a maximum score of 30 points [29]. A score of 23 points or below is considered cognitive impairment [30,31]. TMT-A is a widely used test of attention [32]. Subjects were asked to draw lines, as quickly as possible, connecting numbers 1 through 25, which were randomly arranged on a page, from smallest to largest. The time taken was recorded with a digital stopwatch.

2.3. Statistical Analysis

Subjects were first divided into groups by gait speed to conduct logistic regression analysis for factors related to fast and slow gait speed. Subjects were divided into a group with a gait speed of

1.3m/s or above (fast) as defined by Quach et al. [2] and a group below 1.3m/s (slow). Statistical analysis was performed as follows.

First, independent t-tests and chi-squared tests were used to compare basic attributes, health literacy, various physical functions, and cognitive function between the fast and slow groups. Next, logistic regression analysis was conducted with gait speed (fast or slow) as the dependent variable and indicators found to have significant differences as the independent variables to analyze associations between gait speed and each indicator. Forward stepwise selection (likelihood ratio) was used to select variables. The significance standard for rejecting the null hypothesis was 5% for all tests. Analyses were conducted using SPSS ver.25.

3. Results

After excluding subjects following the exclusion criteria, data of 240 subjects were analyzed. Four subjects were excluded from analysis owing to medical history (e.g., cardiovascular disease), eight owing to MMSE score of 23 or below, and five owing to missing data. Final subjects were 52 men and 188 women with a mean age of 73.8±6.0 years.

Of the 240 subjects, 200 were in the fast gait speed group (≥1.3m/s) and 40 in the slow group (<1.3m/s). Height ($p=0.001$, $d=0.560$), CCHL score ($p=0.004$, $d=0.510$), grip strength ($p=0.020$, $d=0.410$), knee extension strength ($p=0.009$, $d=0.460$), toe-grip strength ($p=0.005$, $d=0.490$), CS-30 score ($p<0.001$, $d=0.820$), sit-and-reach distance ($p=0.015$, $d=0.420$), one-leg stance test time ($p<0.001$, $d=0.670$), and TMT-A score ($p<0.001$, $d=0.720$) were significantly higher in the fast group than in the slow group. Thus, the fast group had higher physical function, attention, and health literacy than the slow group. However, no significant difference was found for age (Tables 1, 2).

Table 1. Subjects' characteristics.

	All subjects (n = 240)			**Slow gait speed (n = 40)**			Fast gait speed (n = 200)			p
Age (years)	**73.8**	**±**	**6.0**	**73.7**	**±**	5.2	73.8	±	6.2	0.859
Gender (male/female)	52	/	188	8	/	32	44	/	156	0.779
Education history (years)	11.8	±	2.3	11.9	±	2.0	11.8	±	2.3	0.849
Height (cm)	154.6	±	7.7	151.0	±	7.6	155.3	±	7.6	0.001
Weight (kg)	53.3	±	8.7	52.5	±	8.3	53.4	±	8.8	0.546
BMI (kg/cm²)	22.3	±	3.0	23.0	±	2.7	22.1	±	3.1	0.114
Chronic diseases										
Hypertension	94 (39.2%)			18 (45.0%)			76 (38.0%)			0.408
Dyslipidemia	30 (12.5%)			7(17.5%)			23(11.5%)			0.295
Diabetes	14(5.8%)			3(7.5%)			11(5.5%)			0.709
Cardiovascular disease	18(7.5%)			2(5.0%)			16(8.0%)			0.745
Respiratory disease	7(2.9%)			1(2.5%)			6(3.0%)			1.000
Osteoporosis	17(7.1%)			2(5.0%)			15(7.5%)			0.745
Orthopedic disease	37(15.4%)			4(10.0%)			33(16.5%)			0.299

Values are presented as means±SD. Abbreviations: BMI, body mass index.

Table 2. Comparison of health literacy, physical function, and cognitive function between the slow and fast gait speed groups.

	All subjects (n = 240)			**Slow gait speed (n = 40)**			Fast gait speed (n = 200)			p
CCHL (point)	**19.3**	**±**	**2.4**	**18.3**	**±**	2.7	19.5	±	2.3	0.004
Grip strength (kg)	25.8	±	6.5	23.6	±	7.1	26.2	±	6.4	0.020
Knee extension strength (%)	43.5	±	10.7	39.5	±	11.1	44.3	±	10.5	0.009
Toe-grip strength (kg)	7.0	±	3.0	5.8	±	3.5	7.3	±	2.9	0.005
Sit-up repetitions (number)	9.0	±	6.5	7.6	±	6.1	9.2	±	6.6	0.163
CS-30 (number)	21.1	±	5.3	17.6	±	5.1	21.8	±	5.1	p<0.001
Sit-and-reach (cm)	34.9	±	9.3	31.7	±	10.8	35.6	±	8.9	0.015
One-leg stance test (sec)	36.6	±	36.0	17.0	±	25.6	40.5	±	36.5	p<0.001
MMSE (point)	28.1	±	1.8	27.9	±	2.0	28.2	±	1.8	0.397
TMT-A (sec)	105.5	±	32.5	18.3	±	35.3	101.8	±	30.6	p<0.001

Values are presented as means±SD. Abbreviations: CCHL, Communicative and Critical Health Literacy; CS-30, 30-second chair-stand test; MMSE, Mini Mental State Examination; TMT-A, Trail Making Test-A.

Table 3. shows the results of the logistic regression analysis with gait speed as the dependent variable. Height (odds ratio [OR]: 1.087, 95% confidence interval [CI]: 1.027–1.150), CCHL score (OR: 1.185, 95% CI: 1.018–1.381), and CS-30 score (OR: 1.187, 95% CI: 1.087–1.296) were extracted as factors influencing gait speed with a correct classification rate of 85.8%. When gait speed was analyzed with only CCHL score as an independent variable, the OR was 1.222 (95% CI: 1.062–1.405) and the correct classification rate was 82.9% (see Table 4).

Table 3. Logistic regression analysis with gait speed as the dependent variable.

	OR	**95% CI**	**p**
Height	1.087	(1.027-1.150)	0.004
CCHL	1.185	(1.018-1.381)	0.029
CS-30	1.187	(1.087-1.296)	p<0.001

Abbreviations: CCHL, Communicative and Critical Health Literacy; CS-30, 30-second chair-stand test; OR, Odds Ratio; 95%CI, 95% confidence interval; Independent variables: Height, CCHL, Grip strength, Knee extension strength, Toe-grip strength, CS-30, Sit-and-reach, One-leg stance test time, TMT-A; Hosmer-Lemeshow p=0.225; Correct classification rate of 85.8%.

Table 4. Logistic regression analysis with gait speed as the dependent variable and health literacy as the only independent variable.

	OR	**95% CI**	**p**
CCHL	1.222	(1.062-1.405)	0.005

Abbreviations: CCHL, Communicative and Critical Health Literacy; OR, Odds Ratio; 95%CI, 95% confidence interval; Independent variables: CCHL; Correct classification rate of 82.9%.

4. Discussion

This study aimed to explore factors associated with gait speed. Logistic regression analysis was performed with gait speed as the dependent variable and factors found to have significant differences between fast and slow gait speed groups (height, CCHL score, grip strength, knee extension strength, toe-grip strength, CS-30 score, sit-and-reach distance, one-leg stance test time, and TMT-A score) as independent variables. The results demonstrated that height, CCHL, and CS-30 significantly affected gait speed. Further, analysis with CCHL as the only independent variable also found a significant impact on gait speed.

CCHL was developed by Ishikawa et al. [21] as a tool to evaluate public health literacy in the average citizen and is comprised of the higher-order interactive and critical literacies rather than

functional literacy. CCHL defines interactive literacy as the competency and motivation to independently take action based on health knowledge with an understanding of health information, and participation in a healthy social group. Critical literacy refers to critically analyzing health information and being able to apply it on a more individual basis to daily events and situations, and, when necessary, being able to utilize such information even when the surrounding environment is not supportive. In other words, those with a high CCHL score can be thought to have healthier habits and high physical activity under all circumstances. A past study using CCHL [21] found that subjects with higher interactive and critical health literacies had healthier lifestyle habits (smoking, diet, exercise, etc.) and significantly fewer subjective symptoms. In a randomized controlled trial on improving health literacy in older adults, Uemura et al. [33] found that an active learning intervention improved health literacy, physical function (including gait speed), physical activity level, and cognitive function in the intervention group. Interestingly, no functional rehabilitation training was offered in the class, implying that the practice of healthy behaviors was a result of individual decisions and efforts made by subjects in their daily lives outside of the intervention. The present study also suggested that subjects with higher health literacy may have had healthier behaviors, such as striving to walk quickly during their physical activities. This is thought to be one reason why health literacy contributes to gait speed.

Gait speed is a product of step length and step count. Decreased gait speed in older adults is primarily due to a reduction in step length [34]. Height also has some level of relationship with step length and stride length [35] and this is likely why height was extracted as a factor influencing gait speed. While a significant difference was found in knee extension strength between the two gait speed groups, it was not extracted as a factor with a significant impact in the logistic regression analysis. Burnfield et al. [36] explored the relationship between decrease in normal gait speed and decrease in lower limb strength in 81 community-dwelling older adult males and found that reduced knee extension strength and reduced normal gait speed were not significantly correlated. This is thought to explain why knee extension strength was not found to affect gait speed in the present study. However, that same study [36] found that reduced hip extension strength was significantly correlated with and was an independent predictor of reduced normal gait speed. Buckinx et al. [37] also reported a significant relationship between decrease in normal gait speed and decrease in hip extension strength. This may be the reason that CS-30 score, which involves not only knee extension strength but also hip extension strength, was extracted as a factor influencing gait speed.

These findings clarify the association of health literacy, height, and CS-30 score with gait speed in community-dwelling older adults. Gait speed is a vital indicator of sarcopenia [38] and frailty [39,40] as well as a clinical indicator of disease status. This study was the first to reveal that health literacy influences gait speed—an essential indicator for both health promotion and clinical purposes. No significant differences in gait speed were found for attributes such as age or education. A study by Uemura et al. [33] also found no significant difference in age or education between the intervention and control groups. Thus, gait speed will likely be maintained by improving or retaining health literacy regardless of age or education level. Health literacy is comprised of individual factors such as age, education, and income; social and environmental factors including social support and health education; and interactive factors such as the systems for health and medical care and the public and patients. Proactive health literacy initiatives will likely continue to become increasingly important in the community at the individual, country, and municipality levels as well as in health and medical care.

This study focused on older adults participating in a community older adult social exchange program who did not require assistance. In other words, subjects were older adults who can be said to have relatively high health literacy. Older adults who do not or cannot participate in such programs are more likely to develop health and medical issues and should be studied in the future.

Author Contributions: Conceptualization, K.A. and S.M.; methodology, K.A., S.M.; formal analysis, K.A. and H.I.; investigation, K.A., S.M., H.N., K.N., H.I., K.S., T.A., A.G., J.H.; resources, S.M.; data curation, K.A., S.M., H.N., K.N., H.I., K.S., T.A., A.G., J.H.; writing-original draft preparation, K.A.; writing –review and editing, K.A.,

S.M., H.N., K.N., H.I., K.S., T.A., A.G., J.H.; visualization, K.A.; supervision, S.M. and J.H.; project administration, S.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Japanese Physical Therapy Association.

Acknowledgments: We would like to thank Editage (www.editage.com) for English language editing.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

1. Lauretani, F.; Russo, C.R.; Bandinelli, S.; Bartali, B.; Cavazzini, C.; Di Iorio, A.; Corsi, A.M.; Rantanen, T.; Guralnik, J.M.; Ferrucci, L. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. *Journal of applied physiology* **2003**, *95*, 1851-1860, doi:10.1152/japplphysiol.00246.2003.
2. Quach, L.; Galica, A.M.; Jones, R.N.; Procter-Gray, E.; Manor, B.; Hannan, M.T.; Lipsitz, L.A. The nonlinear relationship between gait speed and falls: the Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly of Boston Study. *J Am Geriatr Soc* **2011**, *59*, 1069-1073, doi:10.1111/j.1532-5415.2011.03408.x.
3. Studenski, S.; Perera, S.; Patel, K.; Rosano, C.; Faulkner, K.; Inzitari, M.; Brach, J.; Chandler, J.; Cawthon, P.; Connor, E.B., et al. Gait speed and survival in older adults. *Jama* **2011**, *305*, 50-58, doi:10.1001/jama.2010.1923.
4. Menz, H.B.; Lord, S.R.; Fitzpatrick, R.C. Age-related differences in walking stability. *Age and ageing* **2003**, *32*, 137-142, doi:10.1093/ageing/32.2.137.
5. Perez-Sousa, M.A.; Venegas-Sanabria, L.C.; Chavarro-Carvajal, D.A.; Cano-Gutierrez, C.A.; Izquierdo, M.; Correa-Bautista, J.E.; Ramirez-Velez, R. Gait speed as a mediator of the effect of sarcopenia on dependency in activities of daily living. *J Cachexia Sarcopenia Muscle* **2019**, *10*, 1009-1015, doi:10.1002/jcsm.12444.
6. Haider, S.; Luger, E.; Kapan, A.; Titze, S.; Lackinger, C.; Schindler, K.E.; Dorner, T.E. Associations between daily physical activity, handgrip strength, muscle mass, physical performance and quality of life in prefrail and frail community-dwelling older adults. *Quality of life research : an international journal of quality of life aspects of treatment, care and rehabilitation* **2016**, *25*, 3129-3138, doi:10.1007/s11136-016-1349-8.
7. Oh, B.; Cho, B.; Choi, H.C.; Son, K.Y.; Park, S.M.; Chun, S.; Cho, S.I. The influence of lower-extremity function in elderly individuals' quality of life (QOL): an analysis of the correlation between SPPB and EQ-5D. *Arch Gerontol Geriatr* **2014**, *58*, 278-282, doi:10.1016/j.archger.2013.10.008.
8. Chou, C.H.; Hwang, C.L.; Wu, Y.T. Effect of exercise on physical function, daily living activities, and quality of life in the frail older adults: a meta-analysis. *Archives of physical medicine and rehabilitation* **2012**, *93*, 237-244, doi:10.1016/j.apmr.2011.08.042.
9. Montero-Odasso, M.; Schapira, M.; Soriano, E.R.; Varela, M.; Kaplan, R.; Camera, L.A.; Mayorga, L.M. Gait velocity as a single predictor of adverse events in healthy seniors aged 75 years and older. *The journals of gerontology. Series A, Biological sciences and medical sciences* **2005**, *60*, 1304-1309, doi:10.1093/gerona/60.10.1304.
10. Karpman, C.; DePew, Z.S.; LeBrasseur, N.K.; Novotny, P.J.; Benzo, R.P. Determinants of gait speed in COPD. *Chest* **2014**, *146*, 104-110, doi:10.1378/chest.13-2017.
11. Iwakura, M.; Okura, K.; Shibata, K.; Kawagoshi, A.; Sugawara, K.; Takahashi, H.; Shioya, T.; Wakasa, M. Gait characteristics and their associations with clinical outcomes in patients with chronic obstructive pulmonary disease. *Gait Posture* **2019**, *74*, 60-65, doi:10.1016/j.gaitpost.2019.08.012.
12. Bousquet, J.; Dinh-Xuan, A.T.; Similowski, T.; Malva, J.; Ankri, J.; Barbagallo, M.; Fabbri, L.; Humbert, M.; Mercier, J.; Robalo-Cordeiro, C., et al. Should we use gait speed in COPD, FEV1 in frailty and dyspnoea in both? *Eur Respir J* **2016**, *48*, 315-319, doi:10.1183/13993003.00633-2016.
13. Figueiredo, P.; Ribeiro, P.A.; Bona, R.L.; Peyre-Tartaruga, L.A.; Ribeiro, J.P. Ventilatory determinants of self-selected walking speed in chronic heart failure. *Medicine and science in sports and exercise* **2013**, *45*, 415-419, doi:10.1249/MSS.0b013e318277968f.
14. Watson, N.L.; Rosano, C.; Boudreau, R.M.; Simonsick, E.M.; Ferrucci, L.; Sutton-Tyrrell, K.; Hardy, S.E.; Atkinson, H.H.; Yaffe, K.; Satterfield, S., et al. Executive function, memory, and gait speed decline in well-functioning older adults. *The journals of gerontology. Series A, Biological sciences and medical sciences* **2010**, *65*, 1093-1100, doi:10.1093/gerona/glq111.

15. Lundin-Olsson, L.; Nyberg, L.; Gustafson, Y. "Stops walking when talking" as a predictor of falls in elderly people. *Lancet* **1997**, *349*, 617, doi:10.1016/S0140-6736(97)24009-2.
16. Faulkner, K.A.; Redfern, M.S.; Cauley, J.A.; Landsittel, D.P.; Studenski, S.A.; Rosano, C.; Simonsick, E.M.; Harris, T.B.; Shorr, R.I.; Ayonayon, H.N., et al. Multitasking: association between poorer performance and a history of recurrent falls. *J Am Geriatr Soc* **2007**, *55*, 570-576, doi:10.1111/j.1532-5415.2007.01147.x.
17. Federman, A.D.; Sano, M.; Wolf, M.S.; Siu, A.L.; Halm, E.A. Health literacy and cognitive performance in older adults. *J Am Geriatr Soc* **2009**, *57*, 1475-1480, doi:10.1111/j.1532-5415.2009.02347.x.
18. Kivela, K.; Elo, S.; Kyngas, H.; Kaariainen, M. The effects of health coaching on adult patients with chronic diseases: a systematic review. *Patient Educ Couns* **2014**, *97*, 147-157, doi:10.1016/j.pec.2014.07.026.
19. Sorensen, K.; Van den Broucke, S.; Fullam, J.; Doyle, G.; Pelikan, J.; Slonska, Z.; Brand, H.; Consortium Health Literacy Project, E. Health literacy and public health: a systematic review and integration of definitions and models. *Bmc Public Health* **2012**, *12*, 80, doi:10.1186/1471-2458-12-80.
20. Berkman, N.D.; Sheridan, S.L.; Donahue, K.E.; Halpern, D.J.; Crotty, K. Low health literacy and health outcomes: an updated systematic review. *Annals of internal medicine* **2011**, *155*, 97-107, doi:10.7326/0003-4819-155-2-201107190-00005.
21. Ishikawa, H.; Takeuchi, T.; Yano, E. Measuring functional, communicative, and critical health literacy among diabetic patients. *Diabetes Care* **2008**, *31*, 874-879, doi:10.2337/dc07-1932.
22. Tokuda, Y.; Doba, N.; Butler, J.P.; Paasche-Orlow, M.K. Health literacy and physical and psychological wellbeing in Japanese adults. *Patient Educ Couns* **2009**, *75*, 411-417, doi:10.1016/j.pec.2009.03.031.
23. Nakayama, K.; Osaka, W.; Togari, T.; Ishikawa, H.; Yonekura, Y.; Sekido, A.; Matsumoto, M. Comprehensive health literacy in Japan is lower than in Europe: a validated Japanese-language assessment of health literacy. *Bmc Public Health* **2015**, *15*, 505, doi:10.1186/s12889-015-1835-x.
24. Shirooka, H.; Nishiguchi, S.; Fukutani, N.; Adachi, D.; Tashiro, Y.; Hotta, T.; Morino, S.; Nozaki, Y.; Hirata, H.; Yamaguchi, M., et al. Association between comprehensive health literacy and frailty level in community-dwelling older adults: A cross-sectional study in Japan. *Geriatr Gerontol Int* **2017**, *17*, 804-809, doi:10.1111/ggi.12793.
25. Soma, M.; Murata, S.; Kai, Y.; Nakae, H.; Satou, Y.; Murata, J.; Miyazaki, J. Examinations of factors influencing toe grip strength. *J Phys Ther Sci* **2016**, *28*, 3131-3135, doi:10.1589/jpts.28.3131.
26. Bohannon, R.W. Test-retest reliability of hand-held dynamometry during a single session of strength assessment. *Physical therapy* **1986**, *66*, 206-209, doi:10.1093/ptj/66.2.206.
27. Jones, C.J.; Rikli, R.E.; Beam, W.C. A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. *Res Q Exerc Sport* **1999**, *70*, 113-119, doi:10.1080/02701367.1999.10608028.
28. Macrae, P.G.; Lacourse, M.; Moldavon, R. Physical performance measures that predict faller status in community-dwelling older adults. *J Orthop Sports Phys Ther* **1992**, *16*, 123-128, doi:10.2519/jospt.1992.16.3.123.
29. Folstein, M.F.; Folstein, S.E.; McHugh, P.R. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* **1975**, *12*, 189-198, doi:10.1016/0022-3956(75)90026-6.
30. Cullen, B.; Fahy, S.; Cunningham, C.J.; Coen, R.F.; Bruce, I.; Greene, E.; Coakley, D.; Walsh, J.B.; Lawlor, B.A. Screening for dementia in an Irish community sample using MMSE: a comparison of norm-adjusted versus fixed cut-points. *Int J Geriatr Psychiatry* **2005**, *20*, 371-376, doi:10.1002/gps.1291.
31. Tsoi, K.K.; Chan, J.Y.; Hirai, H.W.; Wong, S.Y.; Kwok, T.C. Cognitive Tests to Detect Dementia: A Systematic Review and Meta-analysis. *JAMA Intern Med* **2015**, *175*, 1450-1458, doi:10.1001/jamainternmed.2015.2152.
32. Heilbronner, R.L.; Henry, G.K.; Buck, P.; Adams, R.L.; Fogle, T. Lateralized brain damage and performance on trail making A and B, Digit Span Forward and Backward, and TPT Memory and Location. *Archives of clinical neuropsychology : the official journal of the National Academy of Neuropsychologists* **1991**, *6*, 251-258.
33. Uemura, K.; Yamada, M.; Okamoto, H. Effects of Active Learning on Health Literacy and Behavior in Older Adults: A Randomized Controlled Trial. *J Am Geriatr Soc* **2018**, *66*, 1721-1729, doi:10.1111/jgs.15458.
34. Kaneko, M.; Morimoto, Y.; Kimura, M.; Fuchimoto, K.; Fuchimoto, T. A kinematic analysis of walking and physical fitness testing in elderly women. *Can J Sport Sci* **1991**, *16*, 223-228.
35. Grieve, D.W.; Gear, R.J. The relationships between length of stride, step frequency, time of swing and speed of walking for children and adults. *Ergonomics* **1966**, *9*, 379-399, doi:10.1080/00140136608964399.

36. Burnfield, J.M.; Josephson, K.R.; Powers, C.M.; Rubenstein, L.Z. The influence of lower extremity joint torque on gait characteristics in elderly men. *Archives of physical medicine and rehabilitation* **2000**, *81*, 1153-1157, doi:10.1053/apmr.2000.7174.
37. Buckinx, F.; Croisier, J.L.; Reginster, J.Y.; Petermans, J.; Goffart, E.; Bruyere, O. Relationship between Isometric Strength of Six Lower Limb Muscle Groups and Motor Skills among Nursing Home Residents. *J Frailty Aging* **2015**, *4*, 184-187, doi:10.14283/jfa.2015.70.
38. Cruz-Jentoft, A.J.; Baeyens, J.P.; Bauer, J.M.; Boirie, Y.; Cederholm, T.; Landi, F.; Martin, F.C.; Michel, J.P.; Rolland, Y.; Schneider, S.M., et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age and ageing* **2010**, *39*, 412-423, doi:10.1093/ageing/afq034.
39. Fried, L.P.; Tangen, C.M.; Walston, J.; Newman, A.B.; Hirsch, C.; Gottdiener, J.; Seeman, T.; Tracy, R.; Kop, W.J.; Burke, G., et al. Frailty in older adults: evidence for a phenotype. *The journals of gerontology. Series A, Biological sciences and medical sciences* **2001**, *56*, M146-156, doi:10.1093/gerona/56.3.m146.
40. Shimada, H.; Suzuki, T.; Suzukawa, M.; Makizako, H.; Doi, T.; Yoshida, D.; Tsutsumimoto, K.; Anan, Y.; Uemura, K.; Ito, T., et al. Performance-based assessments and demand for personal care in older Japanese people: a cross-sectional study. *BMJ Open* **2013**, *3*, doi:10.1136/bmjopen-2012-002424.

© 2020 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).