Original article

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Relationship between 3-Meter Backward Walk Test and grip strength in community-dwelling older adults

Chidozie Mbada[1,A-F], Apeji Ozaveshe[2,A-F], Adekola Ademoyegun[3,A-F*], Faatihah Niyi-Odumosu[4,A-F], Micheal Akande[2,A-F], Tadesse Gebrye[1,A-F], Joel Faronbi[5,A-F], Francis Fatoye[1,A-F]

[1]Department of Health Professions, Faculty of Health and Education, Manchester Metropolitan University, United Kingdom

[2]Department of Medical Rehabilitation, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria

[3]Department of Physiotherapy, Osun State University Teaching Hospital, Osogbo, Nigeria

[4]Centre for Health and Clinical Research, Faculty of Health and Applied Science, University of the West of England, Frenchay Campus, Coldharbour Lane, Bristol, United Kingdom

[5]Academy of Nursing, University of Exeter Medical School, United Kingdom

Corresponding author: Adekola Ademoyegun; Department of Physiotherapy, Osun State University Teaching Hospital, Osogbo, Nigeria; email: aademoyegun@gmail.com

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Abstract

Introduction: The 3-Meter Backward Walk Test (3-MBWT) is an important assessment tool used in evaluating neuromuscular control, proprioception, risk of fall and balance. On the other hand, the Hand Grip Strength (HGS) test primarily is used to measure muscular strength or maximum tension generated by one's forearm muscles. This study aimed to assess the relationship between 3-MBWT and HGS among community-dwelling young older adults.

Material and methods: Sixty-two community-dwelling older adults participated in this study. 3-MBWT was measured using a standardized procedure. HGS was measured in line with the guidelines of the American Society of Hand Therapists. Anthropometric variables were assessed following standard procedures. Pearson's correlation coefficient was used to verify the correlation between 3-MBWT and HGS and the influence of socio-demographic factors on both 3-MBWT and HGS.

Results: The mean values for 3-MBWT and HGS were 3.45 ± 0.80s and 29.58 ± 15.53kg. There was a significant correlation between 3-MBWT and HGS ($r = -0.39$; $p = 0.002$). However, there was no significant correlation between 3-MBWT and socio-demographics ($p > 0.05$). Similarly, there was no significant correlation between HGS and socio-demographics ($p > 0.05$), except height ($r = 0.51$, $p < 0.001$).

Conclusions: The 3-MBWT and HGS were significantly correlated with one another. Anthropometric characteristics did not influence the 3-MBWT. Only height and sex showed a significant influence on HGS. Therefore, both 3-MBWT and HGS may serve as useful functional outcome measures for fall predictability and frailty in older adults.

Keywords: ageing, frailty, muscle strength, walking

Introduction

The 3-Meter Backward Walk Test (3-MBWT) is an important assessment tool used in evaluating neuromuscular control, proprioception, risk of fall, and balance in patients who have had total knee arthroplasty, Parkinson's disease or stroke, and also in older adults [1–4]. The 3-MBWT has been found to be more sensitive in determining the risk of falls when compared to other outcome measures such as the Berg Balance Scale and Timed Up and Go test [5]. This test has proven to be reliable, inexpensive, safe, easy to apply, and necessary to perform activities of daily living such as getting out of the way of a sudden obstacle, backing up to a chair, and opening a door [6]. Recently, it has been reported that the 3-MBWT is more sensitive at diagnosing age-related changes in balance and mobility compared to forward walking, thereby making this assessment tool highly suitable when evaluating the risk of falls in older adults [4]. Furthermore, the 3-MBWT has been proven to be more effective at detecting people with a high risk of falling than tests such as the Timed Up and Go test, Four Square Step test, and Five Times Sit-to-Stand test, in which you primarily walk forward or sideways [6]. Also, the test has been determined to accurately determine fallers in older adults [7]. In addition, the 3-MBWT usually involves greater dependence on neuromuscular control, which makes up for the lack of behind vision, although participants are allowed to look behind themselves if they feel uneasy [8–10].

On the other hand, the Hand Grip Strength (HGS) test primarily is used to measure muscular strength or the maximum tension generated by one's forearm muscles. The HGS is often used as an indicator of the overall well-being of an individual [11]. The HGS can be standardized with normative or reference values with which the baseline evaluation and subsequent assessments can be compared. This test is often done using a hand-held dynamometer [12] and it is a reliable indicator of several conditions associated with aging. In particular, HGS provides important prognostic information regarding young older adults' future trajectories [13], especially the risk of falls [14].

Both the HGS and walking speed are objective measures of overall muscle strength and physical function [15]. Independently, low HGS has been found to have a significant association with a higher risk of mortality [16] and disability [17]. At the same time, walking speed has also been reported to be associated with a greater risk of mortality [18] and disability [19]. With the increasing aging population, there is growing interest in identifying people at high risk of functional limitations or frailty (i.e. elevated decline in physiologic reserve and function) using objective measures of muscle strength, neuromuscular control, proprioception, risk of fall, and balance. Considering that HGS is associated with physical function and walking ability [20], it seems there is a paucity of evidence on any possible association between HGS and 3-MBWT among young older adults. Specifically, only one study seems to have explored this relationship. However, their findings were largely based on a secondary dataset [21].

Thus, this study aimed to assess the relationship between the 3-MBWT and HGS test among community-dwelling young older adults.

Materials and methods

This cross-sectional study was carried out among young community-dwelling older adults who were resident in Ile-Ife, Osun State, Nigeria. A 'young older adult' was defined in this study as being within the 65–70 years age bracket. Eligible participants were community-dwelling adults with no current episode of musculoskeletal disorders nor any prior participation in physical performance tests involving HGS and 3-MBWT. Participants with a self-reported positive history of hypertension and mental impairment were excluded. The sample size for the study was determined based on the formula by Eng [22]:

$$N = \frac{4(Z)^2 \times P(Q)}{D^2},$$

where N = the desired sample size; Z = the standard normal deviate, 1.96; P = the proportion in the target population estimated to have a particular characteristic, 0.2; Q = 1.0 – P; and D = degree of accuracy required, 0.26.

Hence,

$$N = \frac{4(1.96)^2 \times 0.2(1.0 - 0.2)}{0.26^2} = 61.5.$$

The sample size was approximated as 62.

Outcome measures

3-Meter Backward Walk Test

Participants walked a marked 3-meter distance on a tiled floor. Following a demonstration by one of the researchers, the participants were instructed to align their heels with the tape mark, and when signaled to "go", they were to walk backward as quickly, but as safely as possible. When a participant reached the end of the walk distance, there was another signal from the researcher to "stop". Participants were not permitted to break into a run during the test. Participants were allowed to look behind themselves in order to remain on course if they desired. The researcher walked backward with the participants to ensure safety during the test. The completion time for the walk was measured using a stopwatch. Three trials of the 3-MBWT were completed and the average of all three was recorded [6, 23].

Hand Grip Strength Test

Participants were asked to sit with limbs in position as depicted by the American Society of Hand Therapists procedure for positioning, which stated that during measurement of HGS, subjects should be comfortably seated in a chair of standard height without armrests with both feet flat on the floor, shoulder adducted and neutrally rotated, elbow flexed at 90º, the forearm in neutral position and wrist between 0º and 30º of extension while the HGS test is measured on the dominant hand using the hand dynamometer [24]. A demonstration was done before the participants were asked to do the procedure. The participants were then instructed to squeeze the handle of the hand dynamometer as strongly as they could with their dominant hand for 3–5 seconds with a rest of 15–20 seconds between measurements [25]. The test was performed three times and the mean value was recorded.

The following instruments were used in this study:

i. Hand grip dynamometer (Wo Li Biao, Japan) – This was used to measure the HGS.
ii. Tape measure (Butterfly Brand – Dara, Inc.) – This was used to demarcate a 3-meter distance on the floor for the 3-MBWT.
iii. Stopwatch (Fisherbrand™ Code 46) – This was used to measure the 3-MBWT completion time.
iv. Armless chair – This was used for the HGS test, where the participants were required to be seated.
v. Paper tape: This was used to mark the starting and end points of the 3-meter distance.

Procedure

Ethical clearance for the study was obtained from the Health Research and Ethics Committee of the Institute of Public Health, Obafemi Awolowo University, Ile-Ife, Nigeria (HREC No: IPH/OAU/12/1669). Informed consent was also obtained from each participant before the commencement of the performance tests. The purpose and procedures of the study were explained to the participants. Participants' socio-demographic and clinical information were obtained. Hand dominance was determined by asking participants to throw a ball. After receiving consent from the participants for the study, 3-MBWT and HGS tests were conducted.

Statistical analysis

Descriptive statistics of mean and standard deviation and percentiles were used to summarize data. Pearson's product-moment correlation was used to test the correlation between the 3-MBWT and HGS tests and the influence of socio-demographic factors on both the 3-MBWT and HGStests. The Independent t-test was used to compare 3-MBWT and HGS by gender. The alpha level was set at $p < 0.05$.

Results

The 62 participants in this study comprised 24% males and 76% females. Table 1 shows the general characteristics of the participants.

Tab. 1. General characteristics of the participants (N = 62)

Variable	Mean ± SD
Age [years]	68 ± 2
Height [m]	1.58 ± 0.08
Weight [kg]	65.26 ± 15.18
Body Mass Index [kg/m^2]	26.1 ± 6.2
3-Meter Backward Walk test [s]	3.45 ± 0.80
Hand Grip Strength [kg]	29.58 ± 15.53

SD – Standard deviation.

There was a significant difference in HGS between male and female participants (47.33 ± 16.01kg vs. 23.91 ± 10.30kg; $t = 6.65$; $p = 0.03$) but not on the 3-MBWT (3.25 ± 0.78s vs. 3.51 ± 0.80s; $t = -1.12$; $p = 0.990$). Percentile scores show that for HGS, scores lower than 37.0kg and 15.0kg were regarded as poor HGS scores for males and females, respectively. Scores of 37.0–60.0kg and 18.0–30.0 kg were regarded as good HGS for males and females, respectively.

For the 3-MBWT, less than 2.80 s is regarded as a poor score for both sexes. 2.80–3.80 s is regarded as a good score for males and 2.80–3.90 s for females.

The percentile scores for the HGS test and 3-MBWT by age and sex are presented in Tables 2 and 3, respectively.

The correlation between HGS and 3-MBWT is shown in Figure 1. There was a significant inverse correlation between the 3-MBWT and HGS ($r = -0.39$; $p = 0.002$).

The correlation between socio-demographic factors and each of the 3-MBWT and HGS is shown in Table 4. There were no significant correlations between 3-MBWT and socio-demographic factors ($p > 0.05$). Moreover, there were no significant correlations between HGS and socio-demographic factors ($p > 0.05$), except for height ($r = 0.510$; $p < 0.001$).

Tab. 2. Percentile data on hand grip strength in kilograms by age and sex (N = 62)

Age (years)	Sex	N	Mean ± SD	Minimum	25th percentile	Median	75th percentile	95th percentile	Maximum
65	Male	1	60.00	60.00	60.00	60.00	60.00	60.00	60.00
	Female	11	25.64 ± 8.29	13.00	20.00	25.00	30.00	NA	38.00
	(Male + Female)	12	28.50 ± 12.68	13.00	20.00	26.50	36.00	NA	60.00
66	Male	2	53.50 ± 9.19	47.00	47.00	53.50	NA	NA	60.00
	Female	4	29.00 ± 6.68	23.00	23.50	27.50	36.00	NA	38.00
	(Male + Female)	6	37.18 ± 14.27	23.00	24.50	34.00	50.25	NA	60.00
67	Male	3	50.67 ± 14.01	37.00	37.00	50.00	NA	NA	65.00
	Female	5	32.00 ± 11.40	18.00	23.00	28.00	43.00	NA	48.00
	(Male + Female)	8	39.00 ± 14.96	18.00	28.00	37.50	49.50	NA	65.00
68	Male	4	50.75 ± 11.06	38.00	41.00	50.00	61.25	NA	65.00
	Female	9	22.11 ± 13.42	8.00	13.00	18.00	31.00	NA	47.00
	(Male + Female)	13	30.92 ± 18.44	8.00	17.00	20.00	48.50	NA	65.00
69	Male	1	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	Female	6	22.00 ± 4.00	20.00	20.00	20.00	24.00	NA	30.00
	(Male + Female)	7	23.86 ± 6.12	20.00	20.00	20.00	30.00	NA	35.00
70	Male	4	38.25 ± 25.49	16.00	18.25	31.50	65.00	NA	74.00
	Female	12	19.58 ± 10.77	10.00	12.25	17.50	22.75	NA	50.00
	(Male + Female)	16	24.25 ± 16.87	10.00	13.00	19.00	25.00	NA	74.00
65–70	Male	15	47.33 ± 16.02	16.00	37.00	50.00	60.00	NA	74.00
	Female	47	23.91 ± 10.30	8.00	18.00	20.00	30.00	47.60	50.00

N – number, NA – not applicable, SD – standard deviation.

Tab. 3. Percentile data on 3-Meter Backward Walk Test in seconds by age and sex (N = 62)

Age	Sex	N	Mean ± SD	Minimum	25^{th} percentile	Median	75^{th} percentile	95^{th} percentile	Maximum
65	Male	1	2.70	2.70	2.70	2.70	2.70	2.70	2.70
	Female	11	3.43 ± 0.65	2.50	2.90	3.40	3.90	NA	4.70
	(Male + Female)	12	3.34 ± 0.65	2.50	2.75	3.40	3.85	NA	4.70
66	Male	2	2.55 ± 0.35	2.30	2.30	2.55	NA	NA	2.80
	Female	4	3.3 ± 0.53	2.70	2.78	3.35	3.78	NA	3.80
	(Male + Female)	6	3.05 ± 0.59	2.30	2.60	2.90	3.73	NA	3.80
67	Male	3	3.17 ± 0.55	2.80	2.80	2.90	NA	NA	3.80
	Female	5	3.48 ± 1.06	2.40	2.55	3.40	4.45	NA	5.10
	(Male + Female)	8	3.36 ± 0.87	2.40	2.73	3.15	3.80	NA	5.10
68	Male	4	3.33 ± 0.41	2.80	2.90	3.40	3.68	NA	3.70
	Female	9	3.53 ± 0.87	2.40	2.60	3.70	4.25	NA	4.80
	(Male + Female)	13	3.47 ± 0.75	2.40	2.80	3.60	3.80	NA	4.80
69	Male	1	3.90	3.90	3.90	3.90	3.90	3.90	3.90
	Female	6	3.43 ± 0.96	2.20	2.50	3.40	4.35	NA	4.80
	(Male + Female)	7	3.50 ± 0.92	2.20	2.60	3.70	4.20	NA	4.80
70	Male	4	3.55 ± 1.30	2.10	2.28	3.70	4.68	NA	4.70
	Female	12	3.70 ± 0.86	2.30	3.13	3.65	4.55	NA	4.80
	(Male + Female)	16	3.66 ± 0.94	2.10	2.85	3.65	4.60	NA	4.80
65–70	Male	15	3.24 ± 0.78	2.10	2.80	2.90	3.80	NA	4.70
	Female	47	3.51 ± 0.80	2.20	2.80	3.60	3.90	4.80	5.10

N – number, NA – not applicable, SD – standard deviation.

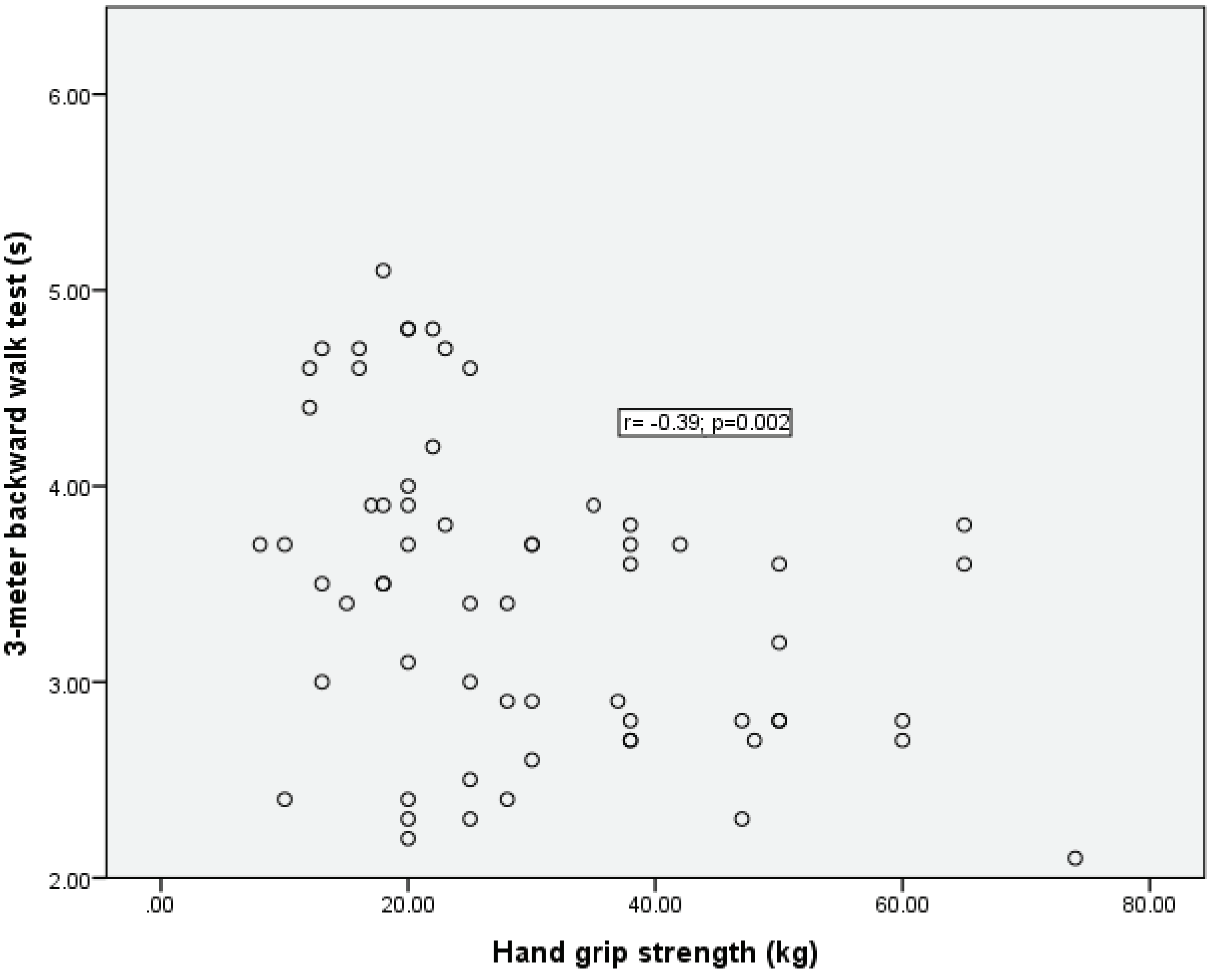

Fig. 1. Scatter plot diagram showing the correlation between the 3-Meter Backward Walk Test and hand grip strength

Tab. 4. Correlation between socio-demographic factors and each of 3-Metre Backward Walk Test and hand grip strength (N = 62)

Variable	3-MBWT r (p)	HGS r (p)
Age [years]	0.17(0.18)	–0.19(0.13)
Height [m]	–0.22(0.08)	0.51(0.001)*
Weight [kg]	0.02(0.88)	0.04(0.77)
Body Mass Index [kg/m^2]	0.11(0.39)	–0.17(0.18)

HGS – hand grip strength, 3-MBWT – 3-Meter Backward Walk Test; * – indicate significant correlation.

Discussion

This study evaluated the levels and correlations between the 3-MBWT and HGS test among community-dwelling young older adults. In addition, the relationships between socio-demographic and anthropometric characteristics with each of the 3-MBWT and HGS tests were investigated. Physical performance measures have been reported as objective measures of functional ability in older adults [26]. The extent to which these physical performance measures assess or predict functional limitations or disability is a subject of more research. A study on older women by Seino found the walk test to be a better marker of poor mobility than an upper-extremity performance test comprising HGS, manipulating pegs in a pegboard, and functional reach [27]. Also, other studies have also revealed that the walk test is a good predictor of overall function [18, 19]. Meanwhile, HGS has long been documented as a valid predictor of functional limitations in older adults [28, 29]. However, there is limited evidence of the association between HGS and the novel 3-MBWT.

The mean age of the community-dwelling young-older adults who participated in this study was 68 ± 2 years. Based on an age classification of the elderly [30], those between the ages of 65 to 70 years were considered eligible in this study as young adults. This narrowed age range was adopted to improve the homogeneity of the sample and to limit the effect of age on the physical performance test among the elderly population. Specifically, some studies have reported a significant effect of age on HGS tests [31]. Also, a study by Valerie et al. reported that age has a significant effect on the 3-MBWT, where the average time to complete the test increased with age [6]. This corroborates the findings from this study as the average time taken to complete the 3-MBWT increased with age, but the age of 66 years was an exception, which is probably due to the size of participants in this age quota.

The mean HGS value among the community-dwelling young older adults in this study was 29.6 kg. This value was comparable with those reported in earlier studies [31,33]. For example, a study by Pratama and Setiati on HGS in the elderly has reported ranges between 28.8 and 16.8 kg [32]. In the present study, there was a significant level of difference between the HGS of male and female young older adults. Based on the meta-analysis by Bohannon et al., HGS was found to be influenced by sex differences [33]. From this study, males had higher HGS scores than females, and a decrease in HGS scores was also observed as age rose; this is in tandem with earlier reports.

The mean 3-MBWT value among the community-dwelling young-older adults in this study was 3.5 s. This value was comparable with those reported in previous studies. A retrospective study by Carter et al. found the average value of the 3-MBWT to be (3.7 ± 2.2 s) among young-older adults with an age range of 65–69 years [6]. In the present study, there was no significant difference between the 3-MBWT results of male (3.3 ± 0.8 s) and female (3.5 ± 0.8 s) young older adults. However, the results showed that females walked backward faster than males. A previous study found that females completed the test faster than males, which correlates with the results obtained from this study [6].

There was a significant inverse correlation between the 3-MBWT and the HGS test. Kim et al. [21] also found a significant inverse correlation between 3-MBWT and HGS scores for males and females. Further studies are needed on 3-MBWT and HGS to validate the findings of this study. In addition, the correlation between 3-MBWT with other physical performance tests is needed to establish the concurrent validity of the test. Furthermore, a reference value for 3-MBWT is required for appropriate use and interpretation of the test results.

Conclusions

The 3-MBWT and HGS tests were significantly correlated with one another among young older adults. Anthropometric characteristics did not influence the 3-MBWT, while only height and gender showed a significant influence on HGS among young older adults.

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Conflict of interest
The authors have no conflict of interest to declare.

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