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Validating the Use of Sphygmomanometer for Measuring Hand Grip Strength and Its Association with Functional Dependency in Older Females

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Abstract

Objective: With global aging, older adults with functional decline is expected to increase. There is a need for simple and valid tools to assess functional decline that can be applied to different settings. The measurement of hand grip strength (HGS) remains a valuable objective tool that can overcome the barriers of self-reported ones. However, use of dynamometer is greatly limited to specialized geriatrics and rehabilitation services in low-resource countries, creating an increasing demand for alternative devices. The aim was to validate the use of a sphygmomanometer for measuring HGS and to determine its association with functional dependency in older females.

Materials and Methods: This cross-sectional study included 100 females aged ≥60 years, recruited from the outpatient clinics and from the caregivers of the inpatients and were subjected to comprehensive geriatric assessment, including functional assessment: activities of daily living (ADL), instrumental ADL (IADL), incidental and planned questionnaire week version, short physical performance battery, and HGS measurements using a Jamar dynamometer and sphygmomanometer.

Results: A significant correlation was found between HGS measured by sphygmomanometer and Jamar dynamometer. A conversion equation of the sphygmomanometer readings into Jamar readings was obtained. The recommended cut-off value to predict ADL dependency was ≤9 for HGS by Jamar with sensitivity 81.4% and specificity 57.9%, while it was ≤60 mmHg sphygmomanometer with a sensitivity of 58.14% and specificity of 78.9%.

Conclusion: The use of a sphygmomanometer for HGS measurements is an acceptable alternative to the Jamar dynamometer. It can predict ADL and IADL dependency in older females.

Keywords: Dynamometer, functional assessment, hand grip strength, sphygmomanometer, conversion equation

Introduction

With the global aging of the population, older adults with functional decline are expected to increase as a result of aging and comorbid chronic diseases (1). This decline presents a major challenge to public healthcare, as it is associated with poor quality of life, increased healthcare utilization and costs, nursing homes admissions, and mortality (2).

Several determinants can influence functional performance in older individuals. A recent prediction model reported a strong association between functional status and gender, gait speed, age, cognition, frailty, comorbidity, grip strength, physical activity, body mass index (BMI), instrumental activities of daily living (IADL), balance, educational level, residential status, sarcopenia, and activities of daily living (ADL) (3).

In both clinical and research settings, the evaluation of physical function has traditionally relied on self-report tools that assess an individual's ability to perform specific functional tasks, such as ADL or IADL scales. Other tools that depend on direct clinical observations of physical performance and muscle strength

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have gained popularity because they provide objective results compared with self- or proxy-reported tools. Moreover, they exhibit greater sensitivity to detect changes (4).

The gait speed test, the short physical performance battery (SPPB), the hand grip strength (HGS), and the Timed Up-and-Go test are widely used objective tools for functional assessment in older adults (4).

HGS is a simple but valid measure of overall muscle strength; it can be used to diagnose sarcopenia and determine the degree of physical disability. Many studies have reported reference values for HGS in different populations (5). Those values differed among different populations due to difference in ethnicities, body size, lifestyles, and cultural backgrounds. Thus, it is of paramount importance to use of population-specific cut-offs for HGS in order to accurately identify older adults at risk of muscle weakness (6).

Nevertheless, the limited availability of dynamometers in low-income countries remains a barrier to applying HGS measurements in different settings, primarily due to high cost, device fragility, and the need for specialized training. As an alternative, a manual sphygmomanometer, which is readily accessible, has been suggested (7).

In the current study, we aimed to validate the use of a sphygmomanometer for measuring HGS and to determine its association with functional dependency in Egyptian community dwelling older females.

Materials and Methods

Study Design and Participants

This cross-sectional study included 100 older females (60 years and older) who were recruited from outpatient clinics and from caregivers of inpatients at Ain Shams University Hospital between November 2022 and April 2023. The study was approved by the Ethics Committee of the Faculty of Medicine at Ain Shams University (approval number: FMASU MD 161 2022, date: 28.07.2022). Informed consent was obtained.

This investigation exclusively recruited elderly female participants to eliminate the influence of gender as a confounding variable on HGS.

Patients with dementia, fracture of one or more limbs or with amputation, distal musculoskeletal disorders, cerebrovascular stroke, or acute medical complaints within the previous month that affected their functional performance were excluded.

Each patient underwent comprehensive geriatric assessment, with an emphasis on functional assessment.

Functional assessment was done using the following tools:

Katz ADL: This assessment assesses the ability of patients to complete basic daily tasks, including transfer, bathing, toileting, continence, dressing, and feeding. The total score ranges from 0 to 6. Scores range from 0 to 5 indicates dependence and 6 indicates independence (8).

Lawton IADL: This measure assesses the patient's ability to perform activities, including shopping, driving, or transportation, telephone use, meal preparation, housework, medication intake, and financial dealing. Total score ranges from 0 to 8. Score range from 0 to 7 indicates dependence and 8 and indicates independence (9).

Incidental and planned exercise questionnaire week version (IPEQ-W) (10): It was designed to assess physical activity and validated for use in geriatrics population. It consists of 6 questions to assess the daily frequency and duration of planned exercise and walking. The questionnaire includes another 4 questions to assess incidental physical activities, including the weekly frequency, the daily duration of walking to go to places, the average time spent daily doing tasks outside the home, and the average time undertaking indoor tasks requiring standing on legs, such as housework or self-care. The average weekly time spent on each IPEQ-W question was calculated by multiplication of the weekly frequency by the daily duration (11).

The total time spent is summed crosswise and presented as hours/week. The score is derived by multiplying the frequency and duration score to formulate a total duration for the week score.

Moderate intensity was defined as 3-6 metabolic equivalent tasks (MET), and vigorous intensity was defined as ≥6 MET. One MET is equivalent to the energy expenditure during rest and is approximately equivalent to 3.5 mL O_2 kg^{-1} min^{-1} in adults. Physical activity data from the IPEQ-W were transformed into energy expenditure estimates as MET using published principles. To calculate weekly physical activity (MET-h $week^{-1}$), the number of hours given to each activity class was multiplied by the specific MET score for that activity.

The HGS measurements: It was measured using two methods. First, a Jamar dynamometer that was used to measure HGS through three trials by the dominant hand, with a 1-min interval between each trial. The results are presented in kilograms of strength, and the highest performance of the three measures was recorded (12). Second, HGS was measured using a sphygmomanometer, the cuff was inflated to 20 mmHg, and the patient exerted maximal grip force on the cuff. Three measurements were taken for the dominant hand, and the highest performance of the three measures was recorded (13).

The short physical performance battery (SPPB): The SPPB is a widely used tool designed to evaluate lower-extremity function and physical performance in older adults. It consists of three components: standing balance, gait speed, and chair stands. Each component is scored from 0 to 4, and the total score ranges from 0 to 12. Higher scores indicate better physical function. SPPB is valuable for assessing functional decline, predicting disability, and guiding interventions to improve mobility and overall health among older individuals. It is a simple and quick test that provides important insights into an individual's physical capabilities (14).

Statistics

The sample size was calculated using the Pass program, assuming a rate of function decline of 60% and sensitivity and specificity of 80%, a sample of 100 participants would be sufficient to detect such a rate at the 0.80 power of the test and 0.05 alpha error. Data were collected, revised, coded, and entered into the Statistical Package for Social Sciences (IBM SPSS) version 23. The quantitative data were presented as means and standard deviations. Qualitative variables are presented as numbers and percentages. The comparison between groups regarding qualitative data was done by using chi-square test. The comparison between two independent groups with quantitative data and parametric distribution was performed using the independent t-test, whereas with non-parametric distribution was done by using Mann-Whitney U test.

Spearman's correlation coefficients were used to assess the correlation between two quantitative parameters in the same group.

The receiver operating characteristic curve was used to assess the best cut-off point according to its sensitivity, specificity, positive predictive value, negative predictive value, and area under the curve (AUC).

Multivariate linear regression analysis was used to assess the factors associated with Jamar and equation to calculate it. The confidence interval was set to 95% and the margin of error accepted was set to 5%.

Results

The mean age of the participants was 66.65±6.08 years, 52% of them were widows; the mean BMI was 31.48±6.82, with 56% of the participants were obese and 67% were illiterate. Regarding medical comorbidities, 35% were diabetic, 52% were hypertensive, and 78% had osteoarthritis (Table 1).

As regards functional assessment the mean ADL and IADL scores were 5.39±1.07 and 6.88±1.92, respectively. Dependency in ADL and IADL occurred in 43% and 37% of participants, respectively. The mean physical activity of the participants during the previous week using the IPEQ-W was 17.94±24.47 METs. Regarding SPPB, the mean total balance score was 2.19±1.85; mean score of gait speed was 1.86±1.20; mean score of repeated chair test was 1.18±1.33 and the mean total score of the test was 5.23±3.89. The mean HGS values by Jamar dynamometer and sphygmomanometer were 8.00±5.00 kg/strength and 112.52±66.42 mmHg, respectively (Table 2).

Functional dependency in ADL dependency was significantly associated with age, mini mental status examination (MMSE) score, geriatric depression scale (GDS) score, IADL, HGS (Jamar), HGS (sphygmomanometer), IPEQ-W, and SPPB (Table 3).

IADL dependency was significantly associated with age, MMSE score, IADL, HGS (Jamar), HGS (sphygmomanometer), IPEQ-W, and SPPB, but not with GDS score (Table 3).

Figure 1 and Table 4 show the AUC, sensitivity, and specificity values of HGS using a sphygmomanometer and SPPB score for prediction of ADL and IADL dependency.

The recommended cut-off value to predict ADL dependency was ≤9 kg for HGS (Jamar) with sensitivity 81.4% and specificity 57.9%, while it was ≤60 mmHg (sphygmomanometer) with a sensitivity of 58.14% and specificity of 78.95%.

Table 1. The baseline characteristics of the participants

		n=100
Age (years)	**Mean ± SD**	66.65±6.08
Marital status	**Single**	3 (3.0%)
	Married	40 (40.0%)
	Widow	52 (52.0%)
	Divorced	5 (5.0%)
BMI (kg/m²)	**Mean ± SD**	31.48±6.82
BMI classification	**Normal**	17 (17.0%)
	Overweight	27 (27.0%)
	Obese	56 (56.0%)
Education level	**Illiterate**	67 (67.0%)
	Primary school	7 (7.0%)
	Preparatory school	4 (4.0%)
	Secondary school	10 (10.0%)
	Highly educated	12 (12.0%)
Medical comorbidities		
Diabetes mellitus		35 (35.0%)
Hypertension		52 (52.0%)
Ischemic heart disease		14 (14.0%)
Heart failure		7 (7.0%)
Atrial fibrillation		0 (0.0%)
Osteoporosis		16 (16.0%)
Osteoarthritis		78 (78.0%)
Fall		2 (2.0%)
Chronic liver disease		10 (10.0%)
Chronic kidney disease		7 (7.0%)
MMSE score mean ± SD		26.27±2.73
GDS score mean ± SD		5.83±1.78

SD: Standard deviation, BMI: Body mass index, MMSE: Mini mental status examination, GDS: Geriatric depression scale

The recommended cut-off value to predict IADL dependency was ≤8 kg for HGS (Jamar) with sensitivity 72.97% and specificity 53.97%, while it was ≤60 mmHg (sphygmomanometer) with a sensitivity of 51.35% and specificity of 71.43%.

As observed, the HGS measured by the Jamar dynamometer was more sensitive but less specific than that measured by the sphygmomanometer in predicting ADL and IADL dependency. There was a positive correlation between HGS measured using the Jamar dynamometer and the sphygmomanometer (r=0.622, p<0.001), and HGS measurement using Jamar was inversely correlated with age (r=-0.361, p<0.001) (Table 5).

Table 2. The functional status of the participants as assessed by ADL, IADL, IPEQ-W, SPPB, HGS

Tool	Items	n=100
ADL, n (%)	Bathing	94 (94.0%)
	Dressing	96 (96.0%)
	Toileting	97 (97.0%)
	Transfer	95 (95.0%)
	Continence	60 (60.0%)
	Feeding	97 (97.0%)
	Score mean ± SD	5.39±1.07
	Dependency	43 (43.0%)
IADL, n (%)	Telephone	89 (89.0%)
	Shopping	93 (93.0%)
	Food preparation	87 (87.0%)
	Housekeeping	78 (78.0%)
	Laundry	78 (78.0%)
	Transportation	95 (95.0%)
	Medications	80 (80.0%)
	Finances	88 (88.0%)
	Score mean ± SD	6.88±1.92
	Dependency	37 (37.0%)
IPEQ-W, mean ± SD	Total activity	17.94±24.47
	Incidental activity	14.40±18.91
	Walking activity	6.07±10.44
	Planned activity	3.47±6.16
	Planned walking activities	3.02±5.26
	Planned sport activities	0.31±2.16
Short physical performance battery, mean ± SD	Total balance score	2.19±1.85
	Repeated chair stand	1.18±1.33
	Gait score	1.86±1.20
	Total score	5.23±3.89
Hand grip strength, mean ± SD	Jamar dynamometer (kg/strength)	8.00±5.00
	Sphygmomanometer (mmHg)	112.52±66.42

ADL: Activities of daily living, IADL: Instrumental ADL, IPEQ-W: Incidental and planned exercise questionnaire week version, SPPB: Short physical performance battery, HGS: Hand grip strength, SD: Standard deviation

Linear regression analysis for factors associated with HGS, as measured by a Jamar dynamometer, was performed to establish the conversion equation to predict HGS in kg/strength using HGS measured in mmHg using a sphygmomanometer and age as follows:

HGS as measured by Jamar (kg/strength) =10.390 + [(0.078 x HGS as measured by sphygmomanometer in mmHg) + (-0.134 x age in years)].

Discussion

The current study aimed to validate the use of a sphygmomanometer for measuring HGS and to determine its association with functional dependency in older females. The prevalences of ADL and IADL dependency for community dwelling females in the current study were 43% and 37%, respectively. A previous study by Millán-Calenti et al. (15) reported ADL dependency at 34.6% and IADL dependency at 52.1%. Discrepancies between the two studies could stem from variations in participants mean age and comorbidities. The mean age of the participants in the current study was 66.65±6.08 years, notably younger than the 75.09±7.54 years observed in the study by Millán-Calenti et al. (15). Additionally, our study excluded cases of stroke and dementia, which were not excluded in Millán-Calenti et al.'s (15) study.

Lee (16) recommended extending the use of HGS beyond research settings to include routine testing in hospitals and community healthcare. HGS was found to be a powerful predictor not only of muscle mass and physical activity levels but also of various health outcomes, including nutritional status, chronic disease incidence, quality of life, ability to perform ADL, length of hospital stay, and mortality risk. The present study aimed to validate the use of a simple, widely available sphygmomanometer as a method for measuring HGS as an alternative to the Jamar dynamometer.

The current study showed a positive correlation between HGS measured using the Jamar dynamometer and sphygmomanometer, while HGS (Jamar) was inversely correlated with age. These findings come in line with a previous study which reported a higher correlation between HGS measurements by the Jamar dynamometer and sphygmomanometer, with a correlation coefficient of 0.835 (17). This supports the potential significance of sphygmomanometers in HGS measurements. The positive correlation between HGS measured by the Jamar dynamometer and sphygmomanometer was reported in multiple previous studies in different populations with different comorbid conditions (18-20).

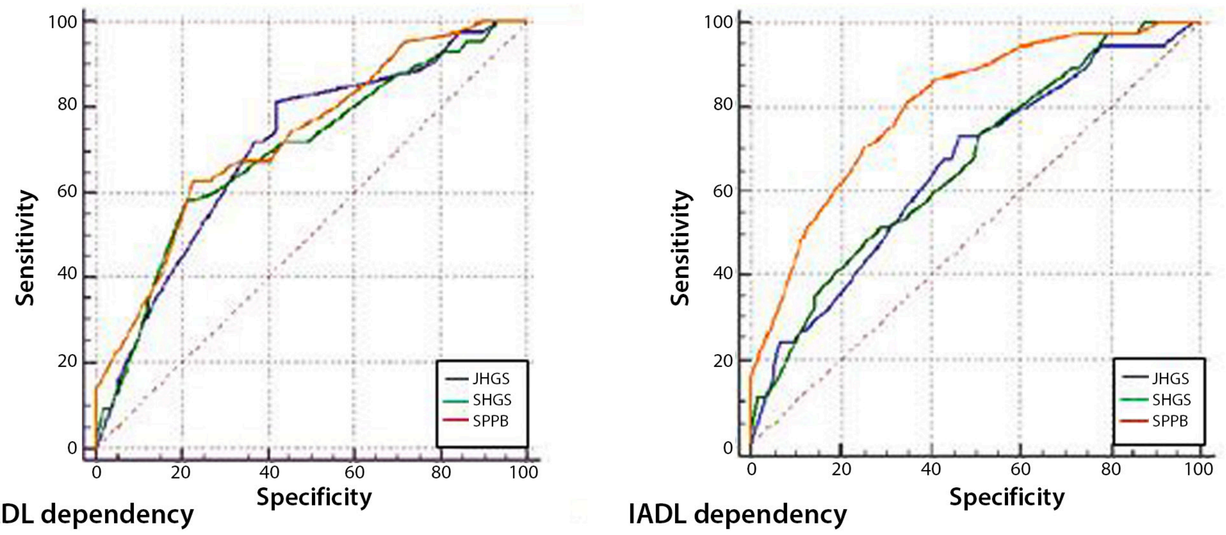
Based on the current analysis, a new formula has been formulated to estimate HGS measurement using a sphygmomanometer in older Egyptian females. The equation was able to predict the Jamar grip strength value in older adults using a sphygmomanometer as follows: HGS as measured by Jamar (kg/strength) =10.390 + [(0.078 x HGS as measured by sphygmomanometer in mmHg) + (-0.134 x age in years)]. This equation can be used to unify the reporting of HGS measurement by both tools.

Yahin et al. (21) reported that based on regression analysis, the prediction formula resulted in HGS values using a sphygmomanometer. The HGS can be measured using the following prediction formula (21).

Table 3. Clinical characteristics of those with ADL and IADL dependency

		ADL		p	IADL		p
		Independent	Dependent		Independent	Dependent	
		n=57	n=43		n=63	n=37	
Age (years)	**Mean ± SD**	65.3±4.88	68.44±7.05	0.010	64.83±4.47	69.76±7.18	<0.001
BMI (kg/m²)	**Mean ± SD**	30.51±6.12	32.77±7.53	0.101	31.18±7.65	31.99±5.15	0.573
BMI classification	**Normal**	11 (19.3%)	6 (14.0%)	0.692	14 (22.2%)	3 (8.1%)	0.117
	Overweight	16 (28.1%)	11 (25.6%)		18 (28.6%)	9 (24.3%)	
	Obese	30 (52.6%)	26 (60.5%)		31 (49.2%)	25 (67.6%)	
MMSE score	**Mean ± SD**	26.96±2.58	25.35±2.68	0.002	26.98±2.4	25.05±2.87	0.001
GDS score	**Mean ± SD**	5.44±1.73	6.35±1.73	0.010	5.67±1.79	6.11±1.76	0.198
HGS (Jamar) (kg/strength), mean ± SD		10±5	6±4	<0.001	9±5	6±5	0.008
HGS (sphygmomanometer) (mmHg), mean ± SD		130.54±67.02	70.51±34.64	<0.001	126.66±67.59	70.32±31.58	<0.001
ADL, mean ± SD					5.7±0.46	4.86±1.53	<0.001
ADL dependency, n (%)					19 (30.2%)	24 (64.9%)	0.001
IADL (mean ± SD)		7.49±1.07	6.07±2.45	<0.001			
IADL dependency, n (%)		13 (22.8%)	24 (55.8%)	<0.001			
IPEQ-W total activity, mean ± SD		20.9±24.1	14.02±24.69	0.003	24.41±25.74	6.92±17.52	<0.001
SPPB total score, mean ± SD		6.53±3.74	3.51±3.43	<0.001	6.7±3.66	2.73±2.9	<0.001

ADL: Activities of daily living, IADL: Instrumental ADL, BMI: Body mass index, MMSE: Mini mental status examination, GDS: Geriatric depression scale, HGS: Hand grip strength, SD: Standard deviation, IPEQ-W: Incidental and planned exercise questionnaire week version, SPPB: Short physical performance battery



ADL dependency

IADL dependency

Figure 1. ROC curve analysis for AUC of HGS (Jamar, sphygmomanometer) and SPPB for predicting ADL and IADL dependency

ROC: Receiver operating characteristic, AUC: Area under the curve, HGS: Hand grip strength, SPPB: Short physical performance battery, ADL: Activities of daily living, IADL: Instrumental ADL, JHGS: Hand grip strength using Jamar, SHGS: Hand grip strength using sphygmomanometer

Table 4. The accuracy of HGS (Jamar, sphygmomanometer) and SPPB for predicting ADL and IADL dependency

	Variable	Cut-off	AUC	SE	95% CI	Sensitivity	Specificity	p
ADL dependency	JHGS	≤9	0.707	0.0516	0.608 to 0.794	81.40%	57.89%	<0.001
	SHGS	≤60	0.697	0.0534	0.597 to 0.785	58.14%	78.95%	<0.001
	SPPB	≤2	0.728	0.0502	0.630 to 0.812	62.79%	77.19%	<0.001
IADL dependency	JHGS	≤8	0.656	0.0556	0.554 to 0.748	72.97%	53.97%	0.005
	SHGS	≤60	0.665	0.0549	0.564 to 0.756	51.35%	71.43%	0.003
	SPPB	≤5	0.803	0.0443	0.712 to 0.876	81.08%	65.08%	<0.001

ADL: Activities of daily living, IADL: Instrumental ADL, AUC: Area under the curve, HGS: Hand grip strength, JHGS: Hand grip strength by Jamar dynamometer, SHGS: Hand grip strength by sphygmomanometer, SPPB: Short physical performance battery, CI: Confidence interval, SE: Standard error

Table 5. The correlation between JHGS, SHGS, ADL, and IADL

		JHGS	SHGS
Age	Spearman's rho	-0.36	-0.29
	p	<0.001	0.003
JHGS	Spearman's rho	.	0.62
	p		<0.001
SHGS	Spearman's rho	0.62*	.
	p	<0.001	
ADL	Spearman's rho	0.36*	0.36
	p	<0.001	<0.001
IADL	Spearman's rho	0.28*	0.30
	p	0.005	0.002

*: Positive correlation
JHGS: Hand grip strength by Jamar dynamometer, SHGS: Hand grip strength by sphygmomanometer, ADL: Activities of daily living, IADL: Instrumental ADL

Right HGS prediction formula: 0.0854 x right sphygmomanometer + [11.5642 x sex (female =0, male =1)] + 3.4243 x hand width – 0.2951 x age

Left HGS prediction formula: 0.0883 x left sphygmomanometer + [12.6581 x sex (female =0, male =1)] + 2.6562 x hand width – 0.2281 x age

Pujianita et al. (22) identified a conversion equation for the Jamar grip strength value using sphygmomanometer (0.1157 × sphygmomanometer grip strength value) – (5.696 × sex) + (0.0824 × age) (female =1, male =0).

The variations in the formulas across studies can be attributed to differences in body size and ethnicity. Furthermore, the two fore-mentioned studies included participants of both genders and elaborated equations adjusted for gender.

Regarding HGS measurements and functional dependency, the mean HGS values obtained using both the Jamar dynamometer and sphygmomanometer were significantly lower among the dependent group. These results align with a prior study that documented that the mean HGS score among functionally dependent females was 15.5±0.5 kg/strength compared to 18.5±0.2 kg/strength among those without functional decline (23). Although we obtained similar results, the mean HGS of our participants were lower for both the functionally dependent and independent groups compared with a previous report by Alexandre et al. (23). This difference could be attributed to personal characteristics regarding body size, medical comorbidities, and cognitive function. In the current population obesity constituted 56%, contrasting with 26.7% in the report by Alexandre et al. (23). To minimize the influence of confounding variables, we excluded patients with stroke, and 4% of the participants of their study had stroke (23). Similarly, the present study excluded patients with dementia to reduce the number of cofounders, resulting in a higher baseline MMSE score (26.27±2.73) compared with a previous study (16.1±0.1). The association between HGS and cognitive function was observed in a prospective analysis within this study revealed a significant association between HGS and cognitive function. Every 5 kg increase in HGS was associated with a 0.97 (95% confidence interval: 0.93, 0.99) lower odds of developing future cognitive impairment or experiencing cognitive decline (24). Furthermore, a systematic review and meta-analysis of cross-sectional studies demonstrated a higher prevalence of cognitive impairment in individuals with sarcopenia than in those without, even after controlling for potential confounders such as gender, age, depression, education level, functional status, and medical comorbidities (25).

In this study, HGS measurements obtained using both dynamometer and sphygmomanometer were correlated with SPPB, ADL, and IADL scores. This suggests a possible association between muscle strength, physical performance, and functional status in elderly women. However, the causal relationship between muscle strength and functional dependency requires further prospective studies.

Sallinen et al. (26) conducted a study to determine the ideal HGS cut-offs for predicting mobility limitations in older adults. They analyzed data from men and women aged 55 and older. The overall cut-off points were 37 kg for men and 21 kg for women. For men, BMI-specific cut-offs were slightly more accurate, with values of 33 kg for normal-weight men, 39 kg for overweight men, and 40 kg for obese men. BMI-specific cut-offs for women were not significantly better than the overall cut-off (26).

A meta-analysis found that low muscle strength, low physical performance, and low muscle mass were associated with increased dependency on ADL and IADL in older adults. The association between low HGS and ADL dependency had an odds ratio of 1.51, whereas that for IADL dependency, it was 1.59. The association between low SPPB scores and ADL dependency had an odds ratio of 3.49, whereas for IADL dependency, the odds ratio was 3.09. These findings suggest that maintaining muscle strength and physical performance is important for preserving independence among older adults (27).

This study found that ADL and IADL dependencies were significantly linked to MMSE, GDS, SHGS, JHGS, IPEQ-W, and SPPB scores. Age was significantly associated with IADL dependency. A previous study reported a negative association between depression and ADL and IADL dependency (28).

Beltz et al. (29) conducted a multivariate analysis and suggested that age, gender, and ADL disability were identified as significant determinants of IADL disability. Both ADL and IADL disability were found to be inversely correlated with physical health-related quality of life. Increasing age was only significantly associated with IADL disability, not with ADL disability or physical health-related quality of life (29).

This study found that people with lower levels of physical activity (lower IPEQ-W scores) were more likely to be dependent on ADLs and IADLs. This finding suggested a negative association between the level of physical activity and functional dependency. This association is bidirectional, meaning that each variable can influence the others.

It is well known that physical activity can prevent many chronic conditions, thereby reducing the likelihood of disability. The World Health Organization has recommended regular physical exercise as an effective and affordable preventive measure for reduced functional performance in older adults (30).

According to Miller et al. (31), engaging in regular physical activity can help slow down the decline in function and independence. For those with severe compared with less severe ADL disability, even the lowest degree of physical activity level decreased the likelihood of progressive disability (odds ratio: 0.45, $p<0.001$) (31). Even in frail older adults, exercise training programs improved walking speed, balance, and the ability of older adults to perform their ADLs (32).

Study Limitations

The current study supported the use of sphygmomanometers as an affordable alternative to the Jamer dynamometer for HGS measurement in older females. This study provided a novel formula to report HGS measured by a sphygmomanometer in an alternative Jamar unit. The main limitations of this study include the relatively small sample size. Moreover, further longitudinal studies are needed to detect the impact of HGS measured by sphygmomanometer on incidental functional dependency.

Conclusion

The study provided cut-offs of different objective tools to assess functional dependency and supported the use of sphygmomanometers for HGS measurement among older females.

Ethics

Ethics Committee Approval: The study was approved by the Ethics Committee of the Faculty of Medicine at Ain Shams University (approval number: FMASU MD 161 2022, date: 28.07.2022). The objective of the study was to evaluate patients. The confidentiality of data was assured.

Informed Consent: Informed consent was obtained.

Authorship Contributions

Surgical and Medical Practices: E.M.A.M.M., S.A.H., D.R., K.E.E., Concept: E.M.A.M.M., S.A.H., D.R., K.E.E., Design: E.M.A.M.M., S.A.H., D.R., K.E.E., Data Collection or Processing: E.M.A.M.M., K.E.E., Analysis or Interpretation: E.M.A.M.M., S.A.H., D.R., K.E.E., Literature Search: E.M.A.M.M., S.A.H., D.R., K.E.E., Writing: E.M.A.M.M., S.A.H., D.R., K.E.E.

Conflict of Interest: No conflict of interest was declared by the authors.

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