ORIGINAL RESEARCH

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Indicators of Low Handgrip Strength and its Association with Poor Sleep Quality among Community-dwelling Older Adults: A Cross-Sectional Study in Egypt

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Abstract

Objective: Handgrip strength (HGS) has several clinical implications. The study aimed to determine indicators of low HGS and its association with sleep quality among community-dwelling geriatric persons.

Materials and Methods: A cross-sectional study included 120 older adults in the community. Charlson Comorbidity Index (CCI) assessed multimorbidity. Anthropometrics included body mass index (BMI) and waist-hip ratio (WHR) measurements. The Pittsburgh Sleep Quality Index (PSQI) and Jamar dynamometer determined sleep quality and HGS in kilograms (kg), respectively. Low HGS was determined according to adjusted cut-offs based on participants' BMI and sex. PSQI score >5 defined as poor sleep quality. The short physical performance battery (SPPB), activities of daily living (IADLs), and instrumental IADLs were performed. The mini-mental state examination, the patient health questionnaire-9 (PHQ-9), and the general anxiety disorder questionnaire-7 (GAD-7) were conducted. Statistical analyses were executed.

Results: The mean age and HGS were 67.26 years and 27.06 kilograms, respectively. Median PSQI score was 7. Seventy-six (63.3%) patients had low HGS while 97 (80.0%) had poor sleep quality. Indicators of low HGS were BMI >27.3 kg/m^2, CCI >2, PHQ-9 >3, and total balance test score ≤2. PSQI score was significantly related to BMI, depression, and low HGS with P 0.007, 0.00, and 0.006, respectively. PSQI scores inversely correlated with IADL (r: -0.197), HGS (r: -0.254), SPPB (r: -0.338) and positively correlated with BMI (r: 0.336), WHR (r 0.189), PHQ-9 (r: 0.457), and GAD-7 (r 0.438). PSQI score >6 identified low HGS with sensitivity 63.16% and specificity 68.18%.

Conclusion: The study identified low HGS indicators. HGS was inversely correlated with PSQI score.

Keywords: Clinical geriatrics, functional performance, handgrip strength, older adults, sleep quality

Introduction

Muscle strength is integral to healthy aging and predicts disability and mortality in older adults (1). Muscle weakness occurs due to age-related changes, malnutrition, and a sedentary lifestyle. It starts in middle age with a gradually progressive decline in physical performance (1). Currently, the handgrip strength (HGS) test using handgrip dynamometers is one of the most applicable methods to assess muscle strength (1). HGS is a surrogate for muscle strength in both upper and lower limbs among healthy individuals and older individuals with illnesses (1). Low HGS represents declined muscle performance and increases the hazards of disease, frailty, and all-cause mortality (2). However, there are different definitions of low HGS. First, "sarcopenia low HGS" defined as a maximum of grip strength less than 26 kilogram (kg) in men or less than 16 kg in women (2). Second, "low reference HGS" is defined as HGS below the population reference HGS value as calculated by a formula in accordance with the age, sex, height, and weight of the sampled population.

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Third, "lowest 20% HGS", is defined as the lowest 20% of HGS among participants adjusted to body mass index (BMI) and sex (2). Factors affecting HGS include socio-demographic factors as age, educational level, and income. Also, behavioral factors such as smoking, alcohol consumption, and physical activity are related to HGS. Furthermore, BMI and comorbidities such as hypertension, diabetes mellitus, and malignancy could markedly affect HGS (1). Therefore, HGS should be routinely evaluated in geriatric patients.

On the other hand, aging is associated with alterations in sleep architecture and a higher prevalence of sleep disorders. That necessitates meticulous assessment of sleep quality to improve physical performance and quality of life among older adults (3). Poor sleep quality has been linked to deterioration in the muscular system with adverse health outcomes including poor physical performance and mobility limitations (4). Recently, investigators have studied the association between muscle strength and sleep characteristics in various populations (4). HGS was strongly associated with sleep duration, subjective sleep quality, and poor daytime functioning (4). Despite studying the indicators of low HGS in previous studies (1), few studies assessed the association between sleep quality, HGS and physical performance with objective tests among geriatric persons in the community. Accordingly, the study intended to define the indicators of low HGS by several objective tests and evaluate its association with sleep quality among older adults in the community.

Materials and Methods

Ethical Consideration

The study protocol was reviewed and accepted by the institutional ethical committee members in the Faculty of Medicine, Ain Shams University (approval number: FMASU MS 456/2023, date: 22.08.2023). It was obtained from each participant before inclusion in the study.

Calculation of the Required Sample Size

Based on another study (5), low HGS prevalence was found to range from 34 to 51 percent with a power of 90 percent and an alpha error of 5 percent. The estimated number of participants was 120 older people. The program for sample size calculation was Stata 10.

Study Design and Participants' Selection Criteria

An observational cross-sectional study involved 120 participants. The inclusion criteria were patients aged ≥60 years who attended the clinics at the geriatrics hospital, a specialized hospital in geriatric health services and care at Ain Shams University, Cairo, Egypt. Data collection was conducted through simple random sampling from April 1, 2023 to January 4, 2024. Exclusion criteria included patients admitted to the hospital, patients who had a disabling deformity or a fracture preventing the performance of assessment tools, those diagnosed with dementia, and patients on medications affecting sleep such as sedative-hypnotics and psychoactive medications.

Study Procedures

History Taking and Physical Examination

Clinical variables, demographics, and special habits were obtained through medical history taking. Co-morbidity burden estimated by the Charlson Comorbidity Index (CCI) (6). Anthropometric measurements included body weight in kg, height, waist circumference (WC), and hip circumference (HC) all in centimeters (cm). BMI is calculated by dividing weight in kg by the height in meters squared (kg/m^2) (6). Obesity is defined as a BMI ≥30 kg/m^2, with obesity class I (BMI 30-34.9 kg/m^2) and obesity class II (BMI 35-39.9 kg/m^2) (7). The waist-hip ratio (WHR) is calculated by dividing WC by HC, utilizing the same units of measurement for both (8).

Evaluation of Sleep Quality

Sleep quality was determined for each participant based on the Pittsburgh Sleep Quality Index (PSQI) questionnaire. It is a reliable tool for assessing the overall sleep quality among different populations. It includes 19 items, divided into 7 domains reflecting the intensity of sleep in the following ways: personal sleep quality, sleep disturbance, sleep latency, habitual sleep efficiency, sleep duration, daily dysfunction, and sleeping pills consumption. Each component of the previously mentioned domains has a score range from 0 of 3. Accordingly, a total PSQI score can ranges from 0 to 21. A higher total score of PSQI reflects poorer sleep characteristics (9). A total PSQI score of more than five defined poor sleep quality among participants in the study (10).

Evaluation of Handgrip Strength

A hydraulic hand dynamometer (Jamar hydraulic dynamometer, J00105) was utilized to evaluate HGS in kg. The participants completed 3 trials for the dominant hand. The measurements were recorded in kg. The highest value of the 3 measurements was selected as the final measurement of HGS (11). Low HGS (kg) was defined according to different cut-offs based on BMI and sex of each participant (12). As follows:

Females:

- ≤17 kg (BMI ≤23)
- ≤17.3 kg (BMI 23.1-26)
- ≤18 kg (BMI 26.1-29)
- ≤21 kg (BMI >29)

Males:

- ≤29 kg (BMI ≤24)
- ≤30 kg (BMI 24.1-26)
- ≤30 kg (BMI 26.1-28)
- ≤32 kg (BMI >28)

Accordingly, participants were classified as those with normal or low HGS.

Evaluation of Physical and Mental Performance

We implemented several geriatric assessment tools for functional and cognitive evaluation. Basic activities of daily living (ADL) reflected the participants' capabilities to perform basic self-care tasks including transfer, dressing, toileting, feeding, bathing, and continence (13). Instrumental activities of daily living (IADLs) reflected the participant's capabilities for maintaining an independent life including financial dealing, telephone use, laundry, shopping, transportation, cooking, and taking their medications (14). Additionally, short physical performance battery (SPPB) was used to reflect physical performance status through the assessment of lower limb functions. SPPB included an assessment of gait speed, balance, and chair standing ability (15). These tasks reflect independence in physical performance (15). Conversely, mini-mental state examination (MMSE) assessed cognitive performance with a total score of 30 points (16). MMSE assesses various intellectual aspects including time and place orientation, recall capabilities, language, calculation abilities, attention, and visuo-spatial skills (16).

Evaluation of Anxiety and Depression

The general anxiety disorder questionnaire-7 (GAD-7) was utilized to assess anxiety. It is a self-report anxiety questionnaire with total scores ranging from 0 to 21. A higher GAD-7 score reflects a higher anxiety level (17). The patient health questionnaire-9 (PHQ-9) was utilized to assess depression. It consists of 9 items with a total score of 0 to 27 (18). A total PHQ-9 score ≥5 defines depression (18). Accordingly, patients were categorized into 2 groups including those with and without depression.

Statistics

The Statistical Package for the Social Sciences (SPSS) version 27 was utilized for data analysis. Qualitative variables were presented as numbers and percentages. Quantitative variables were shown as the mean and the standard deviation (SD) for parametric data, and the median and the interquartile range (IQR) for non-parametric data. The analogy between groups regarding qualitative data was conducted by the chi-square test and/or Fisher Exact test if the expected count was less than five in any cell. The analogy between two independent groups with quantitative data and parametric distribution was performed by an independent t-test while the analysis of nonparametric distributions was conducted using the Mann-Whitney test. The area under the curve (AUC) of the receiver operating characteristic (ROC) was utilized to detect the best cut-offs of factors associated with low HGS. The Kruskal-Wallis test was used to compare groups. The Spearman correlation was used to evaluate the relationship between two quantitative parameters. Correlation coefficient (r) values were positive or negative, and are interpreted as follows: $0 > r \leq \pm 0.19$ means very low correlation, $\pm 0.2 \leq r \leq \pm 0.39$ means low correlation, $\pm 0.4 \leq r \leq \pm 0.59$ means moderate correlation, $\pm 0.6 \leq r \leq \pm 0.79$ means high correlation, and $\pm 0.8 \leq r \leq \pm 1.0$ means very high correlation. Significant indicators of low HGS were determined based on logistic regression analyses. The confidence interval (CI) was set to 95 percent, and the margin of error was set to 5 percent. Interpretation of p-value included: p-value >0.05 (non-significant), <0.05 (significant), and <0.01 (highly significant).

Results

The analysis included 120 community-dwelling older adults comprising 37 (30.8%) females and 83 (69.2%) males. The mean age was 67.2±5.4 years. Mean BMI and HGS were 27.53±4.1 (kg/m^2) and 27.06±5.34 (kg), respectively. The median (IQR) of SPPB and PSQI was 7 (6-9) and 7 (5-8), respectively. Ninety-seven (80.8%) and 76 (63.3%) patients had poor sleep quality and low HGS, respectively. Baseline characteristics are described in Table 1 and Table 2.

There were significant differences between those with normal or low HGS regarding BMI, WC, and WHR, with p-values of 0.001, 0.016, and 0.018, respectively. Hypertension and ischemic heart disease were significantly prevalent among those with low HGS with P-values of 0.040 and 0.023, respectively. Median (IQR) of CCI, PHQ-9, GAD-7, SPPB, and PSQI was significantly higher among those with low HGS with p-values of 0.002 and 0.001, 0.005, 0.000 and 0.006 respectively as described in Table 1 and Table 2.

The ROC curve specified cut-off values to differentiate between normal or low HGS levels as shown in Figures 1 and 2. PSQI >6 had a sensitivity of 63.16% and a specificity of 68.18% with an AUC of 0.65 to identify those with low HGS as described in Table 3.

Regression analyses revealed the indicators of low HGS including: BMI >27.3 kg/m^2 [(odds ratio (OR) 4.686, p-value 0.001, 95% CI 1.807-12.152), CCI >2 (OR 2.475, p-value 0.049, 95% CI 1.003-6.111)], PHQ-9 >3 (OR 3.252, p-value 0.012, 95% CI 1.300-8.140), and total balance test score ≤2 (OR 3.938, p-value 0.030, 95% CI 1.146-13.531) as described in Table 4.

Table 1. Participants' characteristics based on handgrip strength: demographic and clinical characteristics

Variables		Whole sample	Handgrip strength		Test value	p	Sig.
			Normal	Low			
			No.=44 (36.7%)	No.=76 (63.3%)			
Age	Mean ± SD	67.26±5.4	66.3±4.6	67.82±5.76	-1.495•	0.138	NS
	Range	60-84	60-78	60-84			
Sex	Female	37 (30.8%)	15 (34.1%)	22 (28.9%)	0.346*	0.557	NS
	Male	83 (69.2%)	29 (65.9%)	54 (71.1%)			
Marital status	Widow	24 (20%)	10 (22.7%)	14 (18.4%)	0.323*	0.570	NS
	Married	96 (80%)	34 (77.3%)	62 (81.6%)			
Educational level	Illiterate	15 (12.5%)	8 (18.2%)	7 (9.2%)	3.675*	0.299	NS
	<6 years	32 (26.7%)	9 (20.5%)	23 (30.3%)			
	6 to 12 years	18 (15%)	5 (11.4%)	13 (17.1%)			
	>12 years	55 (45.8%)	22 (50%)	33 (43.4%)			
Employment	Unemployed	61 (50.8%)	22 (50%)	39 (51.3%)	0.019*	0.889	NS
	Employed	59 (49.2%)	22 (50%)	37 (48.7%)			
Smoking	No smoking	80 (66.7%)	30 (68.2%)	50 (65.8%)	0.527*	0.913	NS
	Ex-smoker	8 (6.7%)	2 (4.5%)	6 (7.9%)			
	Cigarette smoker	29 (24.2%)	11 (25%)	18 (23.7%)			
	Shisha smoker	3 (2.5%)	1 (2.3%)	2 (2.6%)			
BMI	Mean ± SD	27.53±4.17	25.83±3.03	28.52±4.43	-3.564•	0.001	HS
	Range	17.3-38.3	20-33	17.3-38.3			
Categories of BMI	Underweight	1 (0.8%)	0 (0%)	1 (1.3%)	13.814*	0.008	HS
	Normal weight	30 (25%)	16 (36.4%)	14 (18.4%)			
	Overweight	60 (50%)	25 (56.8%)	35 (46.1%)			
	Obese (class I)	23 (19.2%)	3 (6.8%)	20 (26.3%)			
	Obese (class II)	6 (5%)	0 (0%)	6 (7.9%)			
Waist circumference	Mean ± SD	96.21±10.65	93.14± 9.72	97.99±10.81	-2.455•	0.016	S
	Range	73 -120	73-110	74 -120			
Hip circumference	Mean ± SD	101.35±9.39	99.89±9.01	102.2±9.55	-1.304•	0.195	NS
	Range	80-130	80-121	81-130			
Waist-hip ratio	Mean ± SD	0.95±0.06	0.93±0.05	0.96±0.06	-2.405•	0.018	S
	Range	0.75-1.12	0.78-1.06	0.75-1.12			
Calf circumference	Mean ± SD	35.1±2.74	34.61±2.53	35.38±2.83	-1.488•	0.140	NS
	Range	28-42	28-40	28-42			
Comorbidities							
Diabetes mellitus	No	87 (72.5%)	32 (72.7%)	55 (72.4%)	0.002*	0.966	NS
	Yes	33 (27.5%)	12 (27.3%)	21 (27.6%)			
Hypertension	No	70 (58.3%)	31 (70.5%)	39 (51.3%)	4.200*	0.040	S
	Yes	50 (41.7%)	13 (29.5%)	37 (48.7%)			
Ischemic heart disease	No	96 (80%)	40 (90.9%)	56 (73.7%)	5.167*	0.023	S
	Yes	24 (20%)	4 (9.1%)	20 (26.3%)			
Heart failure	No	111 (92.5%)	43 (97.7%)	68 (89.5%)	2.736*	0.098	NS
	Yes	9 (7.5%)	1 (2.3%)	8 (10.5%)			
Old stroke	No	110 (91.7%)	42 (95.5%)	68 (89.5%)	1.305*	0.253	NS
	Yes	10 (8.3%)	2 (4.5%)	8 (10.5%)			
Atrial Fibrillation	No	116 (96.7%)	43 (97.7%)	73 (96.1%)	0.243*	0.622	NS
	Yes	4 (3.3%)	1 (2.3%)	3 (3.9%)			
CCI	Median (IQR)	2 (2-3)	2 (2-3)	3 (2-3)	-3.173≠	0.002	HS
	Range	0-9	0-4	2-9			

The used tests, •: Independent t-test, *: Chi-square test, ≠: Mann-Whitney U test.
CCI: Charlson Co morbidity Index, Sig.: Significant, No.: Number, SD: Standard deviation, BMI: Body mass index, IQR: Interquartile range, NS: Not significant, HS: Highly significant, S: Significant

Table 2. Participants' characteristics based on handgrip strength: geriatric assessment tools and sleep characteristics

Variables		Whole sample	Handgrip strength		Test value	p-value	Sig.
			Normal No.=44 (36.7%)	Low No.=76 (63.3%)			
MMSE	Mean ± SD	27.25±2.18	27.41±2.43	27.16±2.03	0.607•	0.545	NS
	Range	21-30	22-30	21-30			
ADL	Mean ± SD	5.75±0.71	5.91±0.29	5.66±0.86	1.879•	0.063	NS
	Range	2-6	5-6	2-6			
IADL	Mean ± SD	7.23±1.4	7.41±1.19	7.12±1.51	1.098•	0.275	NS
	Range	3-8	4-8	3-8			
PHQ-9	Median (IQR)	3 (1-7)	1 (0-4)	5 (1.5-8.5)	-3.442≠	0.001	HS
	Range	0-18	0-13	0-18			
	Negative	70 (58.3%)	35 (79.5%)	35 (46.1%)	12.861*	0.000	HS
	Positive	50 (41.7%)	9 (20.5%)	41 (53.9%)			
GAD-7	Median (IQR)	0 (0-6)	0 (0-2.5)	3 (0-6)	-2.795≠	0.005	HS
SPPB							
Total balance test score	Median (IQR)	4 (2-4)	4 (3-4)	3 (2-4)	-2.844≠	0.004	HS
	Range	0-4	2-4	0-4			
Gait speed test score	Median (IQR)	2 (1-3)	3 (1-4)	1 (1-)	-3.342≠	0.001	HS
	Range	1-4	1-4	1-4			
Chair stand test score	Median (IQR)	2 (1-3)	3 (2-3.5)	2 (1-3)	-3.094≠	0.002	HS
	Range	1-4	1-4	1-4			
Total SPPB score	Median (IQR)	7 (6-9)	9 (7-11)	7 (6-8)	-4.241≠	0.000	HS
	Range	2-12	4-12	2-11			
PSQI score	Median (IQR)	7 (5-8)	6 (5-7)	7 (6-9)	-2.752≠	0.006	HS
	Range	0-15	1-13	0-15			
Sleep quality	Poor	97 (80.8%)	34 (77.3%)	63 (82.9%)	0.569*	0.451	NS
	Good	23 (19.2%)	10 (22.7%)	13 (17.1%)			

The used tests, •: Independent t-test, *: Chi-square test, ≠: Mann-Whitney U test.
Sig.: Significance, No.: Number, MMSE: Mini-mental state examination, ADL: Activities of daily living, IADL: Instrumental activities of daily living, PHQ-9: Patient health questionnaire-9, GAD-7: General anxiety disorder questionnaire-7, SPPB: Short physical performance battery, PSQI: Pittsburgh sleep quality index, IQR: Interquartile range, NS: Not significant, HS: Highly significant

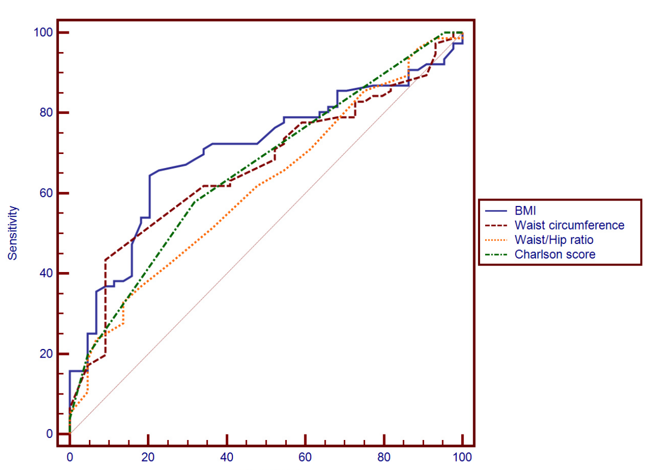

Figure 1. Receiver operating characteristic curve to identify low handgrip strength.

BMI: Body Mass Index

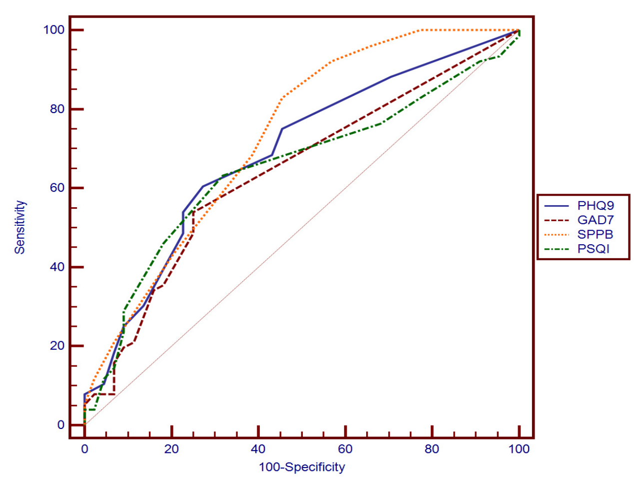

Figure 2. Receiver operating characteristic curve to identify low handgrip strength.

PHQ9: Patient health questionnaire 9, GAD7: General anxiety disorder 7, SPPB: Short physical performance battery, PSQI: Pittsburg Sleep Quality Index

Additionally, we analyzed factors related to PSQI score. The presence of low HGS, depression, and obesity was significantly related to PSQI scores with p-values of 0.006, 0.000, and 0.007, respectively. We reported significant differences in median PSQI (IQR) score, between those having ISHD and stroke with p-values of 0.030 and 0.045, respectively. The association between the median PSQI (IQR) score and each variable is described in Table 5.

Correlation between PSQI scores and quantitative parameters revealed positive correlations with BMI, PHQ-9, and GAD-7 scores, with r values of 0.336 (low correlation), 0.457 (moderate correlation), and 0.438 (moderate correlation), respectively, with and p-values of 0.000. There were inverse correlations with physical assessment scores, including HGS, IADL, and total SPPB scores, with r values of -0.254 (low correlation), -0.197 (very low correlation), and -0.338 (low correlation) respectively, with p-values of 0.005, 0.031, and 0.000, respectively, as demonstrated in Table 6.

Discussion

This research had several advantages compared to others. Firstly, we utilized several robust physical performance measures such as SPPB, ADL, and IADL in addition to the HGS assessment. Secondly, it is the first study to reveal indicators of low HGS

Table 3. Cut-off values defining low handgrip strength based on the receiver operating characteristic curve

Variables	Cut-offs	AUC	Sensitivity	Specificity	PPV	NPV
BMI	>27.3 kg/m^2	0.704	64.47	79.55	84.50	56.50
WC	>100 cm	0.664	43.42	90.91	89.20	48.20
WHR	>0.97	0.615	32.89	86.36	80.60	42.70
CCI	>2	0.659	57.89	68.18	75.90	48.40
PHQ-9	>3	0.688	60.53	72.73	79.30	51.60
GAD-7	>1	0.640	53.95	75.00	78.80	48.50
Total balance test score	≤ 2	0.641	36.84	90.91	87.50	45.50
Gait speed test score	≤ 2	0.674	73.68	56.82	74.70	55.60
Chair stand test score	>2	0.663	57.89	68.18	75.90	48.40
Total SPPB score	≤8	0.730	82.89	54.55	75.90	64.90
PSQI score	>6	0.650	63.16	68.18	77.4	51.7

AUC: Area under the curve, PPV: Positive predictive value, NPV: Negative predictive value, BMI: Body mass index, WC: Waist circumference, WHR: Waist-hip ratio, CCI: Charlson Comorbidity Index, PHQ-9: Patient health questionnaire-9, GAD-7: General anxiety disorder questionnaire-7, SPPB: Short physical performance battery, PSQI: Pittsburgh sleep quality index

Table 4. Indicators of low handgrip strength based on regression analyses

Variables	Univariate analysis				Multivariate analysis			
	p	OR	95% CI for OR		p-value	OR	95% CI for OR	
			Lower	Upper			Lower	Upper
BMI >27.3 kg/m^2	**0.000**	7.058	2.956	16.849	**0.001**	**4.686**	**1.807**	**12.152**
WC >100 cm	**0.000**	7.674	2.495	23.602	0.259	2.843	0.463	17.462
WHR >0.97	**0.033**	2.923	1.089	7.847	0.574	0.628	0.124	3.184
Hypertension	**0.042**	2.262	1.028	4.977	0.375	1.550	0.589	4.077
Ischemic heart disease	**0.030**	3.571	1.134	11.253	0.671	1.378	0.313	6.063
CCI >2	**0.007**	2.946	1.349	6.433	**0.049**	**2.475**	**1.003**	**6.111**
PHQ-9 >3	**0.001**	4.089	1.824	9.167	**0.012**	**3.252**	**1.300**	**8.140**
GAD-7 >1	**0.003**	3.514	1.551	7.963	0.954	1.045	0.233	4.678
Total balance test score ≤2	**0.002**	5.833	1.887	18.032	**0.030**	**3.938**	**1.146**	**13.531**
Gait speed test score ≤2	**0.001**	3.684	1.680	8.079	0.818	1.249	0.188	8.291
Chair stand test score >2	**0.000**	4.189	1.903	9.220	0.697	0.766	0.200	2.928
Total SPPB score ≤8	**0.000**	5.815	2.506	13.495	0.876	1.202	0.118	12.270
PSQI score >6	**0.001**	3.673	1.672	8.071	0.233	1.870	0.668	5.235

Bold = Significant.
BMI: Body mass index, WC: Waist circumference, WHR: Waist-hip ratio, CCI: Charlson Comorbidity Index, PHQ-9: Patient health questionnaire-9, GAD-7: General anxiety disorder questionnaire -7, SPPB: Short physical performance battery, PSQI: Pittsburgh sleep quality index, OR: Odds ratio, CI: Confidence interval

with a specified cut-off for each. Thirdly, we defined low HGS according to BMI and adjusted for sex rather than utilizing a single cut-off value, unlike most other studies. Lastly, the study examined the impact of cognitive and psychiatric domains on both physical performance and sleep quality. The study confirmed the necessity of the multi-dimensional approach toward the geriatric population.

The study explored the predominance of declined physical performance as represented by low HGS and highlighted its association with total PSQI score among community-dwelling older adults. It reflected the high frequency of decreased muscle strength, as indicated by the prevalence of low HGS, affecting 76 (63.3%) participants. Additionally, the median (IQR) PSQI score was statistically higher among this vulnerable group of

Table 5. Relationship between PSQI score and the studied variables

		PSQI score		Test value	p-value	Sig.
		Median (IQR)	Range			
Sex	Female	7 (6-8)	1-14	-1.093•	0.274	NS
	Male	6 (5-8)	0-15			
Marital status	Widow	7 (5.5-9.5)	2-13	-0.725•	0.468	NS
	Married	7 (5-8)	0 -15			
Educational level	Illiterate	6 (4-7)	4-12	4.715≠	0.194	NS
	<6 years	7 (6-8.5)	1-14			
	6 to 12 years	7 (6-10)	2 -12			
	>12 years	6 (4 -8)	0-15			
Employment	Unemployed	7 (6 -8)	1-14	-1.813•	0.070	NS
	Employed	6 (48)	0-15			
Smoking	Negative	7 (5.5-8)	1-14	1.799≠	0.615	NS
	Ex-smoker	5 (2-8)	1-15			
	Cigarette smoker	7 (6-8)	0-12			
	Shisha smoker	6 (4-11)	4-11			
Categories based on BMI	Underweight	12 (12-12)	12-12	14.024≠	0.007	HS
	Normal weight	6 (4-7)	1-13			
	Overweight	7 (5-8)	0-12			
	Obese (class I)	7 (6-9)	2-15			
	Obese (class II)	8.5 (6-14)	6-14			
Comorbidities						
Diabetes mellitus	No	7 (6-8)	0-15	-0.801•	0.423	NS
	Yes	6 (5-8)	1-14			
Hypertension	No	6 (5-8)	0-15	-1.432•	0.152	NS
	Yes	7 (6-8)	1-14			
Ischemic heart disease	No	6 (5-8)	1-14	-2.173•	0.030	S
	Yes	7.5 (6.5-10)	0-15			
Heart failure	No	7 (5-8)	1-15	-0.719•	0.472	NS
	Yes	8 (4-9)	0-14			
Old stroke	No	6 (5-8)	0-15	-2.009•	0.045	S
	Yes	8 (7-10)	2-12			
Atrial fibrillation	No	7 (5-8)	0-15	-0.081•	0.935	NS
	Yes	6.5 (5-10)	4-13			
PHQ-9	Negative depression	6 (4-7)	0-13	-4.668•	0.000	HS
	Positive depression	8 (6-11)	1-15			
HGS	Normal HGS	6 (5-7)	1-13	-2.752•	0.006	HS
	Low HGS	7 (6-9)	0-15			

The used tests •: Mann-Whitney U test; ≠: Kruskal-Wallis test.
BMI: Body mass index, PSQI: Pittsburgh sleep quality index, PHQ-9: Patient health questionnaire-9, IQR: Interquartile range, HGS: Handgrip strength, NS: Not significant, HS: Highly significant, S: Significant

Table 6. Correlation between PSQI score and the other studied variables

	PSQI score	
	r	p-value
Age	-0.149	0.105
BMI	**0.336****	**0.000**
Waist circumference	**0.335****	**0.000**
Hip circumference	**0.219***	**0.016**
Waist-hip ratio	**0.189***	**0.038**
Calf circumference	0.178	0.051
CCI	0.067	0.469
MMSE	0.019	0.838
ADL	-0.135	0.143
IADL	**-0.197***	**0.031**
PHQ-9	**0.457****	**0.000**
GAD-7	**0.438****	**0.000**
HGS	**-0.254****	**0.005**
SPPB score	**-0.338****	**0.000**

Bold = Significant, *: Significant at p-value <0.05; **: Significant at p-value < 0.01. PSQI: Pittsburgh sleep quality index, BMI: Body mass index, CCI: Charlson Comorbidity Index, MMSE: Mini-mental state examination, ADL: Activities of daily living, IADL: Instrumental activities of daily living, PHQ-9: Patient health questionnaire-9, GAD-7: General anxiety disorder questionnaire-7, HGS: Handgrip strength, SPPB: Short physical performance battery

patients, reflecting the significant association between muscle strength and total PSQI scores a representative of sleep quality. These data are supported by several studies (1,4).

The study revealed indicators of low HGS with a specified cut-off value as the following regarding anthropometrics: BMI >27.3 kg/m^2 was a significant indicator of weak HGS, coinciding with previous studies (1). This significant association between low HGS and higher BMI indicates a tendency toward sarcopenic obesity as an ongoing syndrome characterized by increased visceral adiposity declined muscle quality, and subsequent higher health problems, including mortality among older populations (19). In addition, PHQ-9 score >3 was another indicator for low HGS. It supports the significant association between depression and low HGS as found in a previous study among 162, 167 participants in the United Kingdom (20). Additionally, CCI >2 was another significant indicator. Low HGS could be a biomarker of physiological limitations within the body. It is also associated with multi-morbidity in both sexes. Hence, stronger handgrip could reduce disease burden, improve health, and decrease mortality (21). Low HGS is indicative of higher morbidity and mortality in various chronic health conditions including cardiovascular diseases among older adults (4). The study showed hypertension and ischemic heart disease as significant comorbidities affecting HGS, in agreement with several studies (1,21).

The study showed a significant association between HGS and both total, and individual SPPB testing scores. A total balance test score ≤2 was a significant indicator of low HGS. Similarly, a previous study revealed that physical performance metrics, including gait speed, SPPB, time and balance test, and five-times-sit-to-stand test showed poorer outcomes when transitioning from normal HGS to both low HGS and asymmetrical groups (22). Accordingly, HGS testing is a feasible tool for assessing physical functioning among older adults (22).

On the other side, the study showed the clinical implications of physical performance on sleep quality. There was an inverse correlation between total PSQI score, HGS, and SPPB scores. Consistent with the previous studies, our results confirmed the clinical implication of both HGS and SPPB on sleep quality and overall physical performance (4,23). Similarly, IADL scores were inversely related to total PSQI supporting the inverse relationship between functional status and sleep quality as found in several studies (23,24).

The study showed additional factors affecting PSQI scores. Regarding co-morbidities, the median PSQI score was significantly related to both depression and anxiety. It is consistent with a previous analysis of co-morbidities associated with poor sleep where mental health disorders including depression and anxiety had the greatest impact on sleep quality with β values of 1.76 and 1.72, respectively (25). Additionally, obesity, old stroke, and ischemic heart disease significantly affect PSQI scores. Similarly, a previous meta-analysis and systematic review of 108 cohort observational studies showed that shorter sleep periods were associated with the same comorbidities, indicating their negative impact on sleep quality (26). PSQI score was significantly related to higher CCI, which reflects a greater number of comorbidities, that significantly contributed to poorer sleep, as supported by a previous study (25).

Regarding anthropometrics, the analysis revealed a positive correlation between PSQI score and both BMI and WHR, indicating that obesity and visceral adiposity could be related to worse sleep characteristics among geriatric populations. It coincides with another study that revealed a remarkable relationship between higher BMI and WHR with higher PSQI scores ($p<0.05$) (24). These findings supported the negative consequences of metabolic syndrome on sleep quality among older adults (24).

Study Limitations

The study included a relatively small sample. Its cross-sectional design impaired the assessment of causality of the association between the studied variables. Also, PSQI is a subjective sleep assessment tool. The study lacked objective methods such as polysomnography or actigraphy. These assessment methods could capture different parameters and domains of sleep quality

(27). However, the study has contributed to the literature in several aspects. First, the study revealed the indicators of among community-dwelling older adults. It provided age-specific cut-off values for each indicator. Second, the study demonstrated that higher total PSQI scores are significantly and inversely correlated with physical performance parameters including HGS, SPPB, and IADL. Third, the study identified factors related to total PSQI score, as a representative of sleep quality. These data could be beneficial in supporting the limited research on the associations between sarcopenia and sleep quality among older adults in the community.

Conclusion

HGS has several clinical implications among community-dwelling older adults. Indicators of low HGS were BMI >27.3 kg/m^2, CCI >2, PHQ-9 >3, and total balance test score ≤2. PSQI scores were inversely correlated with HGS. PSQI score >6 identified low HGS with a good discriminative ability. Thus, HGS and sleep evaluation are advocated as an integral part of geriatric assessment.

Ethics

Ethics Committee Approval: The study protocol was reviewed and accepted by the institutional ethical committee members in the Faculty of Medicine, Ain Shams University (approval number: FMASU MS 456/2023, date: date: 22.08.2023).

Informed Consent: It was obtained from each participant before inclusion in the study.

Footnotes

Authorship Contributions

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

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