Original Article

The Effect of various chronic Comorbidities on Handgrip Strength in a Sample of Egyptian Elderly

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Abstract:
Background: Handgrip strength is a simple method that reflects elderly general health and physical function. Several factors can affect HGS. It is important to determine these factors in order to provide preventive measures. Therefore, this study aimed to investigate the effect of chronic comorbidities on handgrip strength (HGS).
Methods: Data collected from 154 elderly ≥ 60 years patients during admission in geriatric hospital. Each was subjected to history taking, BMI, mood, cognitive, nutritional, and assessment of risk of fall by (TUG)Test. Handgrip strength assessment (HGS) using Jamar hydraulic hand dynamometer, the participants were in the seated position, elbow at 90°, handle adjusted to the second position. They applied the maximum grip strength for 3 to 5 s for three times, one minute apart. The maximum HGS was collected from right hand as it was the dominant hand in all participants.
Results: The mean age of the participants was 69.416 ±7.841, the right HGS mean was (12.935±7.663). The number of comorbidities ranged from no comorbidities up to 7 comorbidities, the study investigated the effect of common comorbid conditions on HGS. Increased age, being females, cognitive impairment, malnutrition, underweight, morbid obesity, and the prolonged TUG had significant negative impact on HGS. Regarding different chronic comorbidities, DM and stroke had significantly weaker HGS. While COPD patients had significantly higher grip strength.
Conclusion: Numerous variables can affect HGS, this includes advancing age, female gender, cognitive impairment, malnutrition, low BMI, morbid obesity, the prolonged TUG, and certain chronic comorbidities as DM, and stroke.
Keywords: Handgrip Strength, Elderly, Comorbidities.

Introduction

The demographic transition in the number of elderly people and increased life expectancy worldwide, including Egypt, is associated with an increased number of chronic diseases and their associated disabilities [1,2,3].

HGS is an easy and simple method that is measured by using a hand dynamometer. It is used for the detection of general health and overall body strength and function. It is a good indicator for various problems such as physical disability and gait problems, moreover; it is a good prognostic indicator for detecting patients with a lower chance of being independent after hospitalization. [4,5,6].

Elderly people with impairments in body function will have difficulty living independently as they will face challenges performing their daily activities, requiring the need for caregiver support, leading to changes in their living arrangements and sometimes social isolation, affecting their quality of life. Early muscle strength assessment is crucial to providing early diagnosis and hence, early intervention for those with low muscle strength to prevent progression and negative outcomes. [7.]

HGS is affected by multiple chronic diseases such as anemia, anxiety, CKD stage 3 or above, chronic obstructive airway disease, diabetes, hyperthyroidism and other endocrine disorders, stroke, kyphosis, metabolic syndrome, and obesity. Both subclinical inflammation and insulin resistance could play a role in explaining this association. Lower HGS can be caused by various chronic illnesses, which can lead to negative outcomes like falling. Moreover, lower HGS may be linked to increased incidence of coronary heart disease and strokes, thus; HGS handgrip is a good indicator of general muscle strength and is associated with lower extremity strength as well as general health. [1]

Frailty is a medical syndrome with major consequences in elderly population, with its physical phenotype diagnosis is primarily based on unintentional weight loss, weakness (using HGS measurement), exhaustion, slow gait, and low physical activity. Therefore, weak hand grip strength is a major determinant of frailty, and its associated risk for disability, morbidity, and mortality.[8] HGS as a simple and objective measure of frailty syndrome has gained much scientific attention in the past few years. [8]

The current study investigated the effect of chronic comorbidities on HGS in a group of Egyptian elderly.

Methods:

The study is a cross sectional study, data collected from patients during admission in geriatric hospital Ain shams university hospital. The study population involved 154 elderly 60 years or older that agreed to participate in the study. We excluded those who refused to participate in the study, patients with critical or terminal illness, patients with hand muscle weakness that hinder their ability to use hand grip dynamometer.

Each participant was subjected to:

- **History taking:** (personal history, demographic data, past relevant medical history) and physical examination including BMI calculation.
- **Mood assessment** Using the Arabic version of patient health questionnaire**.**[9]
  - score ≥10 categorized with moderate to severe major depression. (Moderate depression 10-14, moderately severe depression score 15-19, severe depression more than 20)
  - score less than 10 were categorized as no depression. (Includes normal group score less than 5 and minor symptoms score 5-9)
- **Cognitive assessment tests used to diagnose cognitive impairment:** Mini-mental state examination.[10]
  - Total score 30
  - Scores for cognitive impairment was according to age and education. [11]
- **Nutritional assessment by** Min nutritional assessment scale. [12]
  - Total score of the short form of the scale is 14.
  - Score 12-14 is normal.
  - Score 8-11 at risk of malnutrition.
  - Score 0-7 is malnourished.
- **Hand drip strength:** (using Jamar hydraulic hand dynamometer)

- Handgrip Strength (HGS) was measured, in kilograms (kg), using Jamar hydraulic hand dynamometer. Measurements were obtained with the participants in the seated position, elbow at 90°, and the handle adjusted to the second position. then they applied the maximum grip strength for 3 to 5 s. The procedure was performed three times with an interval of one minute between each measurement. The maximum HGS was identified considering the highest HGS value.

- **Assessment of risk of fall using** Time Up and Go Test **(TUG).**[13]
  - **Timed Up and Go (TUG)** was used to assess mobility. The participants performed specific sequences of movements: getting up from the chair, walking three meters, turning around, walking back to the chair, and sitting again. Patient was allowed to use his usual walking aid, but no physical assistance is allowed.
  - the shorter time indicates better physical function. The score of ≥13.5 seconds is used as a cut-point to identify those at increased risk of falls. [14,15]

Statistical Analysis

Appropriate statistical methods used to present and analyses of the data. Quantitative variables presented as mean and standard deviation and the independent t-test was used to compare the two groups. Qualitative data was presented as frequency and proportion. ANOVA test was used to determine differences between results from three or more unrelated groups. Statistical Package: Data entry and statistical analysis was on a personal computer using statistical package for social science (SPSS) version 26.0.

Results

Table (1) shows the demographic data of the participants. the mean age of the cases was **(69.416±7. 841).** The study included 72 females and 82 males. All the participants had the right hand as their dominant one. The mean HGS of the cases was **(12.935±7.663)**
Assessment of BMI was measured, participants were classified as 4 were underweight (2.6%), 42 were normal (27.27%), 39 were overweight (25.32%), 21 were obesity grade1 (13.64%), 12 were obesity grade2 (7.79%), 16 were morbid obesity (10.39%), and 20 participants were not measured as they were bedridden.
Table (1)
Regarding cognitive function, there was 36(23.38%) cases with cognitive impairment. while 31 cases (20.13%) were depressed. 43 participants were at risk of malnutrition (27.92%), while 32 were malnourished (20.78%). The participants were classified according to frailty criteria as 76 robust cases (49.35%), 23 prefrail (14.94%), and 55 frail (35.71%). The mean for TUG was **(21.4 ±12.4)**, there was 45 participants scored < 13.5 seconds (29.22%), while72 participant scored ≥13.5 seconds or more (46.75%), however 37 participants didn't have the TUG test measured as they had gait difficulties.
Table (1)

Table (2) investigated the number of comorbidities in each participant (classified from no comorbidities to one comorbidity up to 7 comorbidities). As regard the prevalence of each comorbid condition: **65** had Diabetes (DM) (42.21%), while 84 were hypertensive (54.55%), as regard cardiac disease **18** were **AF** (11.69%)**, 51 ISHD** (33.12%)**, 43** were **HF** (27,92%). Regarding chest comorbidities **45** were **COPD** (29.22%)**, 9**

bronchial asthma cases (5.84%) **and 6 IPF cases** (3.9%)**,** 40 participants had chronic kidney disease (25.97%) while **33** had chronic liver disease(21.43%) , 22 had stroke(14.29%), 4 had malignancy (2.6%), and 50 participant were anemic(32.47%). As regard patients with stroke included in the study, they either had left sided weakness which was not the side of measurement for HGS used in the study or they had no residual weakness.

Table (3) illustrated the effect of various factors on HGS in elderly. As regards age, it showed that increased age was associated with weaker HGS as those aged 60-70 years were better than those older than 70 **(P-Value 0.011).** HGS was higher in males compared to females **(P-Value <0.001)**.

Cognitive impairment was associated with weaker HGS **(P-Value 0.001)**, although depressed participants had weaker HGS, it didn't reach the level of statistical significance **(P-Value 0.424)**. Those at risk of malnutrition or malnourished had weaker hand grip strength compared to those with normal nutrition **(P-Value 0.004) Table 3.**

Moreover, those with the prolonged TUG (≥13.5 sec) had lower mean HGS **(P-Value <0.001).** Regarding the impact of BMI on HGS, both the participants with underweight or morbid obesity or obesity class 2 groups had weaker HGS **(P-Value <0.010).**

Table (4) illustrated the effect of number of comorbidities as well as the various chronic diseases on HGS. As regards the number of comorbidities, those who had no comorbidities had the best HGS, while those with 7 comorbidities had the lowest HGS, yet this didn't reach the level of the statistical significance **(P-Value 0.0386)**. The participants with diabetes mellitus (DM) and stroke had weaker HGS **(P-Value 0.003), (P-Value 0.005),** respectively. While those with COPD had higher grip strength **(P-Value <0.001).**

Table (1): Demographic data of participants, HGS, time up and go test, frailty, BMI, cognition, depression and nutritional assessment.

Total				
Age	**Range**	60	-	94
	Mean ±SD	69.416	±	7.841
		N		**%**
Age group	**60-70 Years**	100		64.94
	>70 Years	54		35.06
Gender	**Female**	72		46.75
	Male	82		53.25
RT handgrip	**Range**	2	-	36
	Mean ±SD	12.935	±	7.663
TUG	**Range**	**5**	**-**	**55**
	Mean ±SD	**21.496**	±	**12.425**
		N		**%**
TUG	**<13.5 Sec**	**45**		**29.22**
	>=13.5 Sec	**72**		**46.75**
	Not done	**37**		**24.03**
Frailty	**Robust**	76		49.35
	Prefrail	23		14.94
	Frail	55		35.71
BMI	**Under weight**	4		2.60
	Normal	42		27.27
	Overweight	39		25.32
	Obesity class 1	21		13.64
	Obesity class 2	12		7.79
	Morbid obesity	16		10.39
	Not done	20		12.99
Cognitive Impairment	**No**	118		76.62
	Yes	36		23.38
Depression	**No**	121		78.57
	Yes	31		20.13
	Not done	2		1.30
Nutritional Assessment	**Normal**	76		49.35
	At risk	43		27.92
	Malnourished	32		20.78

*TUG = time up and go test, BMI= body mass index,

Table (2): Chronic Comorbidities Among Participants

Comorbidity		N	%
DM	**No**	89	57.79
	Yes	65	42.21
HTN	**No**	70	45.45
	Yes	84	54.55
AF	**No**	136	88.31
	Yes	18	11.69
IHD	**No**	103	66.88
	Yes	51	33.12
HF	**No**	111	72.08
	Yes	43	27.92
COPD	**No**	109	70.78
	Yes	45	29.22
Asthma	**No**	145	94.16
	Yes	9	5.84
IPF	**No**	148	96.10
	Yes	6	3.90
CKD	**No**	114	74.03
	Yes	40	25.97
CLD	**No**	121	78.57
	Yes	33	21.43
Stroke	**No**	132	85.71
	Yes	22	14.29
Malignancy	**No**	150	97.40
	Yes	4	2.60
Anemia	**No**	104	67.53
	Yes	50	32.47
No of comorbidities	**No**	4	2.60
	One	26	16.88
	Two	28	18.18
	Three	40	25.97
	Four	29	18.83
	Five	14	9.09
	Six	9	5.84
	Seven	4	2.60

*DM= diabetes mellitus, HTN= hypertension, AF= atrial fibrillation, ISHD= ischemic heart disease, HF= heart failure, COPD= chronic obstructive airway disease, IPF= interstitial pulmonary fibrosis, CKD= chronic kidney disease, CLD= chronic liver disease

Table (3): Relation between HGS and demographic data as well as depression, cognition, nutrition, BMI & TUG

		RT Handgrip				T-Test or ANOVA	
		N	**Mean**	**±**	**SD**	**T or F**	**P-value**
Age group	**60-70 Years**	100	14.080	±	7.723	2.569	0.011*
	>70 Years	54	10.815	±	7.146		
Gender	**Female**	72	9.292	±	5.003	-6.160	<0.001*
	Male	82	16.134	±	8.175		
Cognitive Impairment	**No**	118	14.102	±	7.725	3.547	0.001*
	Yes	36	9.111	±	6.131		
Depression	**No**	121	13.331	±	8.108	0.862	0.424
	Yes	31	11.645	±	5.707		
	Not done	2	9.000	±	4.243		
Nutritional Assessment	**Normal**	76	15.197	±	8.222	4.691	0.004*
	At risk	43	10.581	±	6.558		
	Malnourished	32	10.875	±	6.384		
TUG	**<13.5 Sec**	45	19.000	±	7.705	34.771	<0.001*
	>=13.5 Sec	72	11.958	±	6.115		
	Not done	37	7.459	±	4.959		
BMI	**Under weight**	4	10.500	±	4.435	2.912	0.010*
	Normal	42	13.048	±	8.052		
	Overweight	39	15.564	±	8.861		
	Obesity class 1	21	14.000	±	6.164		
	Obesity class 2	12	12.667	±	6.169		
	Morbid obesity	16	12.688	±	6.183		
	Not done	20	7.300	±	5.516		

* p-value of 0.05 or lower is statistically significant

Table (4): Relation between chronic diseases and Rt HGS

		RT Handgrip				T-Test or ANOVA	
		N	**Mean**	**±**	**SD**	**T or F**	**P-value**
DM	**No**	89	14.494	±	8.491	3.033	0.003*
	Yes	65	10.800	±	5.767		
HTN	**No**	70	13.729	±	8.413	1.174	0.242
	Yes	84	12.274	±	6.960		
AF	**No**	136	12.816	±	7.675	-0.528	0.598
	Yes	18	13.833	±	7.733		
IHD	**No**	103	12.990	±	7.999	0.127	0.899
	Yes	51	12.824	±	7.011		
HF	**No**	111	12.279	±	7.983	-1.717	0.088
	Yes	43	14.628	±	6.554		
COPD	**No**	109	11.450	±	7.107	-3.915	<0.001*
	Yes	45	16.533	±	7.844		
Asthma	**No**	145	13.117	±	7.828	1.186	0.238
	Yes	9	10.000	±	3.162		
IPF	**No**	148	12.865	±	7.642	-0.563	0.574
	Yes	6	14.667	±	8.733		
CKD	**No**	114	13.114	±	7.590	0.488	0.626
	Yes	40	12.425	±	7.945		
CLD	**No**	121	12.628	±	7.367	-0.952	0.343
	Yes	33	14.061	±	8.696		
Stroke	**No**	132	13.636	±	7.696	2.846	0.005*
	Yes	22	8.727	±	6.065		
Malignancy	**No**	150	13.000	±	7.723	0.643	0.521
	Yes	4	10.500	±	5.000		
Anemia	**No**	104	13.558	±	7.828	1.459	0.146
	Yes	50	11.640	±	7.213		
No of comorbidities	**No**	4	17.000	±	14.283	1.070	0.386
	One	26	11.731	±	8.205		
	Two	28	13.429	±	7.366		
	Three	40	14.275	±	8.255		
	Four	29	11.448	±	6.208		
	Five	14	14.286	±	6.069		
	Six	9	12.667	±	8.185		
	Seven	4	6.500	±	3.416		

* p-value of 0.05 or lower is statistically significant

Discussion

The increase in the number of elderlies in the communities is associated with an increase in comorbidities and subsequent disabilities. HGS is a simple method that could be important in the early detection of a patient's general health and physical activity as well as the risk of being frail. The current study aimed to investigate the effect of chronic comorbidities on HGS in a sample of Egyptian elderly. It was a cross-sectional study, involving 154 elderly participants from the geriatric hospital Ain Shams University Hospitals.

The mean age of the cases was 69.416±7.841, the right HGS mean was (12.935±7.663). Numerous variables affected HGS including older age, female gender, cognitive impairment, malnutrition, low BMI, morbid obesity, and the prolonged TUG. DM, and stroke were associated with weaker HGS.

As regards HGS in different age groups, the mean HGS in age group 60 to 70 was **(14.080±7.723kg)**, while it was lower in those 70 years or older **(10.815±7.146kg) (P-Value 0.011)**. The mean HGS among males was **(16.134±8.175kg),** it was higher compared to females (**9.292±5.003kg) (P-Value <0.001)**.

HGS varies from one study to another depending on the different populations involved in each study, each population were different due to differences in ethnic group, lifestyle, and nutritional habits. **Amaral et al., 2020** [16] investigated the HGS in older people and the results of their study was higher than the current study. Similarly, **PESSINI et al., 2016**[17] conducted a study in Brazil and had higher values than the current study, while **Wiśniowska-Szurlej et al., 2021**[6] conducted a study in southeastern Poland revealing a HGS of 19.98 kg in their participants, approaching the values of our study.

Studies conducted on the measurement of HGS in Egyptian population showed results approaching those of the current study. (**Hamza et al.,2013)**[18] showed that the HGS was between (10.74- 12.54) in males and (9.45-11.12) in females. Another study by **(Wahba et al.,2013)**[19] reported that the mean HGS of all participants was 9.66±2.86 which is slightly lower than HGS measurement in the present study.

(PESSINI et al., 2016)[17], (**Bohannan et al., 2019)**[5]**, (Amaral et al., 2020)**[15], (**Wiśniowska-Szurlej et al., 2021)**[6] all agreed with the current study that the older the cases, the weaker the HGS. **(Amaral et al., 2020)**[16] showed that the difference between age groups 60–69 to 70–79 and 70–79 to ≥80, was − 4.1kg. Moreover (**Wiśniowska-Szurlej et al., 2021)**[6] reported that HGS was 17.97 kg for those aged 80–85 and 16.68 kg in the group over 85 years old. The fore mentioned studies and a study conducted by **(Huang et al., 2022)**[20] were in line with the current investigation regarding the impact of gender on HGS, showing that males had higher HGS than females. This also agreed with study carried on Egyptian population by (**Elbedewy et al., 2020**)[21] and **(Wahba et al.,2013).**[19].

The cases with cognitive impairment had weaker HGS compared to those with normal cognition **(P-Value 0.001)**, although depressed participants had weaker HGS, the level didn't reach statistical significance **(P-Value 0.424)**.

The current findings agreed with (**Yang et al., 2018)**[22]**, (Liu et al., 2019)**[23]**, (Watermeyer et al., 2021)**[24]**, (Huang et**

al., 2022)[20] regarding impact of cognition on HGS. While **(Deary et al., 2011)**[25] **&** **(Ritchie et al., 2016)**[26] reported that there were no association between grip strength and cognitive impairment.
High inflammatory markers, high oxidative stress may play a role in the association between low HGS and cognitive impairment. Moreover, the lower HGS was associated with cognitive impairment due to neurodegenerative changes that affect fine motor skills of the hands due to involvement of the cortical and subcortical brain regions that control hand dexterity. **(McGrath et al.,2019).**[27]

Regarding depression **(Castaneda-Sceppa et al., 2010)**[28]**, (Phillips et al., 2011)**[29], **(PESSINI et al., 2016)**[17]**, (Huang et al., 2022)**[20] all demonstrated an association between hand grip strength and depression, in contrast to **(Taekema et al., 2010)**[30] that showed no such association. for the present study it found no association which can be due to low number of depressed cases.

Depression could be associated with weak HGS through different pathways, the depressed patients tend to avoid physical activity causing muscle weakness. Furthermore, depression coexist with other systemic inflammatory diseases, such as cardiovascular disease, diabetes that may increase peripheral inflammation leading to sarcopenia, and there is association between proinflammatory cytokines such as IL-1, IL-6, TNF-α, and interferon (IFN)-γ that enter the brain causing depressive symptoms and cause muscle atrophy which decreases muscle strength **(Wang et al.,2022)**[31.]

Current results showed that those who were at risk of malnutrition or malnourished had weaker hand grip strength than those with normal nutrition **(P-Value 0.004).** Participants with an underweight BMI or those who were "morbidly obese and in obesity class 2" also had weaker hand grip strength **(P-Value <0.010)**

Previous research on the relationship between HGS and BMI had contradictory results. **(Stenholm et al., 2011)**[32] **&** (**PESSINI et al., 2016)**[17], agreed with the current study that obesity was linked to weaker HGS possibly because obesity increases inflammation and causes alterations in glucose metabolism. However (**Wiśniowska-Szurlej et al., 2021)**[6] disagreed as they illustrated that obesity associated with higher HGS due to relatively a better muscle mass. **(Wearing et al., 2018)**[33] did not report any association between BMI and HGS. The low BMI in the current study was also associated with weak HGS as a result of decreased muscle mass, this agreed with **(Su et al., 2017)**[34] **& (Akbar & Setiati 2018)**[35]**.**

Regarding malnutrition, **(Norman et al., 2010)**[36] agreed with our results showing that malnutrition was associated with weak HGS as decreased nutritional intake may be associated with decreased protein intake causing muscle weakness.

Those with prolonged TUG (≥13.5 sec) had weaker HGS **(P-Value <0.001).** This was in line with **(Porta et al., 2018)**[37]& (**Wiśniowska-Szurlej et al., 2021)**[6] who exhibited a correlation between TUG and muscle strength. Both TUG and HGS were embraced by the European Working Group on Sarcopenia in Older People (EWGSOP) as a marker of muscle strength. (**Cruz-Jentoft et al., 2010)**[38]**.**

Regarding the number of comorbidities, those with no comorbidity had the highest HGS, while those with seven comorbidities had the lowest HGS. However, it didn't reach the level of significance **(P-Value 0.0386)**. Diabetes mellitus (DM) and stroke had weaker HGS **(P-Value 0.003), (P-Value 0.005),** respectively. While surprisingly, those with COPD had higher HGS **(P-Value <0.001)** which may be attributed to the inclusion of cases with mild to moderate COPD in our study.

(Wander PL et al., 2011)[39], (Leenders M et al., 2013) [40], (PESSINI et al., 2016)[17] & **(Huang et al., 2022)[20]** agreed with the current study as they reported that diabetes, and cerebrovascular disease had weaker HGS while their participants with COPD had lower HGS.

(Cheung et al., 2013)[1] showed a significant relation between HGS and the number of chronic diseases. In men, subjects without chronic disease had significantly higher HGS compared to those with two to eight chronic diseases. Yet, female subjects without chronic disease had higher HGS than subjects having four to seven chronic diseases.

Several factors could be involved in the development of weak HGS among diabetic patients such as Low-grade inflammation, insulin resistance that accelerates loss of skeletal muscle mass and increased intramuscular fat infiltration. Diabetic patients also could suffer from peripheral neuropathy and diabetic hand syndrome, including limited joint mobility, flexor tenosynovitis and Dupuytren's disease which could be possible reasons for weak HGS. Moreover, diabetic patients tend to be less physically active. **(Åström et al.,2021)[41]**

Conclusion

Numerous variables can affect HGS, this includes advancing age, female gender, cognitive impairment, malnutrition, low BMI, morbid obesity, the prolonged duration of TUG, and certain chronic comorbidities as DM, and stroke.

Ethical Considerations

An informed consent was obtained from each participant or their caregivers as needed . Participants were oriented by the nature of the study and the data extracted from this study. Approval of the ethical committee of the faculty of medicine, Ain Shams University was taken before beginning of the study **(approval FMASU R215/2023).**

Limitation of the study

we recognized that our study had several limitations. Small sample size that will prevent generalization of results and led to including smaller number of cases for each assessed comorbidity. The lack of using a co-morbidity index scale that may represent the impact of comorbidities better than their number is another limitation to consider in future studies.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not for profit sectors.

Author Contributions

All authors assisted in the collection of samples and patients' data. NG assisted in manuscript drafting and revision. All authors contributed significantly to the study's conception, design.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Reference

1. ***Cheung CL, Nguyen U.D.T, Au E, Tan K.C.B,and Kung A.W.C (2013)***. *Association of handgrip strength with chronic diseases and multimorbidity. A cross-sectional study. Age (Dordr). 2013 Jun; 35(3): 929–941. doi: 10.1007/s11357-012-9385-y.*
2. ***Pais R., Ruano L., Carvalho O.P. and Barros H. (2020).*** *Global Cognitive Impairment Prevalence and Incidence in Community Dwelling Older Adults—A Systematic Review. Geriatrics (Basel); 5(4): 84. doi: 10.3390/geriatrics5040084.*
3. ***Central Agency for Public Mobilization and Statistics (CAPMAS)*** *issued a press release on 29/ 9 /2022.*
4. ***Ling C.H.Y., Taekema D, de Craen A.J.M, Gussekloo J, Westendorp R.G.J, and Maier A.B (2010).*** *Handgrip strength and mortality in the oldest old population: the Leiden 85-plus study. CMAJ.23; 182(5): 429–435.doi: 10.1503/cmaj.091278*
5. ***Bohannon R.W(2019).*** *Grip Strength: An Indispensable Biomarker for Older Adults. Clin Interv Aging; 14: 1681–1691.Published online 2019 Oct 1. doi: 10.2147/CIA.S194543*
6. ***Wiśniowska-Szurlej A, Ćwirlej-Sozańska A, Kilian J, Wołoszyn N, Sozański B & Wilmowska-Pietruszyńska A (2021).*** *Reference values and factors associated with hand grip strength among older adults living in southeastern Poland. Sci Rep.11;11(1):9950. doi: 10.1038/s41598-021-89408-9.*
7. ***Wearing J, Konings P, Stokes M & de Bruin E.D (2018).*** *Handgrip strength in old and oldest old Swiss adults – a cross-sectional study. BMC Geriatr. 6;18(1):266. doi: 10.1186/s12877-018-0959-0.*
8. ***Dudzińska-Griszek J, Szuster K, & Szewieczek J (2017).*** *Grip strength as a frailty diagnostic component in geriatric inpatients Clin Interv Aging. 26:12:1151-1157. doi: 10.2147/CIA.S140192*
9. ***AlHadi A.N., AlAteeq D.A., Al-Sharif E., BawazeerE.M. , Alanazi H, ETet al.,(2017).*** *An arabic translation, reliability, and validation of Patient Health Questionnaire in a Saudi sample. Ann Gen Psychiatry; 16: 32. doi: 10.1186/s12991-017-0155-1*
10. ***Folstein M.F., Folstein S.E. & McHughP. R. (1975).*** *"Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res;12(3):189-98. doi: 10.1016/0022-3956(75)90026-6.*
11. ***Crum RM, Anthony J, & Folstein M (1993).*** *Population-based norms for the Mini-Mental State Examination by age and educational level. JAMA: The Journal of the American Medical Association. 1993;269(18):2386-91*
12. ***Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B (2001).*** *Screening for Undernutrition in Geriatric Practice: Developing the Short-Form Mini Nutritional Assessment (MNA-SF). J. Geront. 2001; 56A: M366-377*
13. ***Podsiadlo D &Richardson S (1991).*** *The Time up and Go as Test of Basic Functional Mobility for Frail Elderly Persons. J of American geriatric society; 39(2):142148.*
14. ***Shumway-Cook A, Brauer S, Woollacott M. (2000).*** *Predicting the probability for falls in community-dwelling older adults using the Timed Up and Go test. Phys Ther., 80 (9): 896-903.*
15. ***Rose, Debra J.;Jones, C. Jessie;Lucchese***,*(2002) Nicole Predicting the Probability of Falls in Community-Residing Older Adults Using the 8-Foot Up-and-Go: A New Measure of Functional Mobility. JOURNAL OF AGING AND PHYSICAL ACTIVITY, 01 Oct 2002, Vol. 10, Issue 4, pages 466 - 475 DOI: 10.1123/japa.10.4.466.*

16. ***Amaral C.D.A, Amaral T.L.M, Monteiro G.T.R, Leite de Vasconcellos M.T., Margare Portela M.C****(2020). Factors associated with low handgrip strength in older people: data of the Study of Chronic Diseases (Edoc-I). BMC Public Health.26;20(1): 395.doi: 10.1186/s12889-020-08504-z*
17. ***PESSINI J, BARBOSA A.R, Santos de Moraes E.B(2016).*** *TRINDADE3Chronic diseases, multimorbidity, and handgrip strength among older adults from Southern Brazil. Rev. Nutr. 29 (1). https://doi.org/10.1590/1678-98652016000100005*
18. ***Hamza S.A, Wahba H, Hegazy M. (2013).*** *Assessment of Handgrip Strength Variables in a Population of Egyptian Elderly. Middle East Journal of Age and Ageing 10(3): 19-23.DOI: 10.5742/MEJAA.2013.103247*
19. ***Wahba H, Abdul-Rahman S.A, Mortagy A (2013).*** *Handgrip strength and falls in community-dwelling Egyptian seniors. Advances in Aging Research 2(4):109-114. DOI: 10.4236/aar.2013.24016*
20. ***Huang J., Wang X., Zhu H., Huang D., Li W., Wang J., Liu Z. (2022).*** *Association between grip strength and cognitive impairment in older American adults Front. Mol. Neurosci., 30 November 2022Sec. Neuroplasticity and DevelopmentVolume 15. doi.org/10.3389/fnmol.2022.973700*
21. ***Elbedewy RMS, El Said SMS , Taha RM (2020).*** *Indicators of Abnormal Hand Grip Strength Among Older Egyptian AdultsJournal of Multidisciplinary Healthcare Volume :13 Pages 387—392. DOI https://doi.org/10.2147/JMDH.S240502*
22. ***Yang, L., Koyanagi, A., Smith, L., Hu, L., Colditz, G. A., Toriola, A. T., et al. (2018).*** *Hand grip strength and cognitive function among elderly cancer survivors. PLoS ONE 13, e0197909. doi: 10.1371/journal.pone.0197909*
23. ***Liu, X., Chen, J., Geng, R., Wei, R., Xu, P., Chen, B., et al. (2020).*** *Sex- and age-specific mild cognitive impairment is associated with low hand grip strength in an older Chinese cohort. J. Int. Med. Res. 48, 300060520933051. doi: 10.1177/0300060520933051*
24. ***Watermeyer, T., Massa, F., Goerdten, J., Stirland, L., Johansson, B., and Muniz-Terrera, G. (2021).*** *Cognitive dispersion predicts grip strength trajectories in men but not women in a sample of the oldest old without dementia. Innovat. Aging 5, igab025. doi: 10.1093/geroni/igab025*
25. ***Deary, I. J., Johnson, W., Gow, A. J., Pattie, A., Brett, C. E., Bates, T. C., et al. (2011).*** *Losing one's grip: a bivariate growth curve model of grip strength and nonverbal reasoning from age 79 to 87 years in the Lothian Birth Cohort 1921. J. Gerontol. B Psychol. Sci. Soc. Sci. 66, 699–707. doi: 10.1093/geronb/gbr059*
26. ***Ritchie, S. J., Tucker-Drob, E. M., Starr, J. M., and Deary, I. J. (2016).*** *Do cognitive and physical functions age in concert from age 70 to 76? Evidence from the Lothian birth cohort 1936. Span J. Psychol. 19, E90. doi: 10.1017/sjp.2016.85*
27. ***McGrath R, Robinson-Lane S.G, Cook S,Clark B, Herrmann S, O'Connor M.L, and Hackneya K.J(2019).*** *Handgrip Strength Is Associated with Poorer Cognitive Functioning in Aging Americans. J Alzheimers Dis. 2019; 70(4): 1187–1196.doi: 10.3233/JAD-190042*
28. ***Castaneda-Sceppa C, Price LL, Noel SE, Bassett Midle J, Falcon LM, Tucker KL (2010).*** *Physical function and health status in aging Puerto Rican adults: The Boston Pueto Rican Health Study. J Aging Health.; 22(5):653-72. http://dx.doi.org/10.1177/08 98264310366738*
29. ***Phillips HJ, Biland J, Costa R, Souverain R (2011).*** *Fiveposition grip strength measures in individuals with clinical depression. J Orthop Sports*

Phys Ther.; 41(3):149-54 .doi.org/10.2519/jospt.20 11.3328

30. ***Taekema DG, Gussekloo J, Maier AB, Westendorp RG, Craen AJ (2010).*** *Handgrip strength as a predictor or functional, psychological and social health: A prospective population-based study among oldest old. Age Aging.; 39(3):3*
31. ***Wang J, Zhou X, Qiu S, Deng L, Li J, Yang L, Wei Q & Dong B (2022).****The Association Between Grip Strength and Depression Among Adults Aged 60 Years and Older: A Large-Scaled Population-Based Study From the Longitudinal Aging Study in India. Front Aging Neurosci. 2022; 14: 937087.doi: 10.3389/fnagi.2022.937087*
32. ***Stenholm S, Sallinen J, Koster A, Rantanen T, Sainio P, Heliovaara M, et al (2011).*** *Association between obesity history and hand grip strength in older adultsexploring the roles of inflammation and insulin resistance as mediating factors. J Gerontol A Biol Sci Med Sci. 2011; 66(3):341-8. http://dx.doi.org/ 10.1093/gerona/glq226*
33. ***Wearing J., Konings P., Stokes M., de Bruin ED (2018).*** *Handgrip strength in old and oldest old Swiss adults—a cross-sectional study. BMC Geriatrics.18(1): p. 266. doi: 10.1186/s12877-018-0959-0.*
34. ***Su L. Q., Yin Z. X., Wang X. C., et al (2017).*** *Study on handgrip strength of elderly ≥60 years old from longevity areas in China. Zhonghua Yu Fang Yi Xue Za Zhi. 2017;51(11):1007–1011.*
35. ***Akbar F and S Setiati S (2018).*** *Correlation between hand grip strength and nutritional status in elderly patients. Journal of Physics: Conf. Series 1073, 042032 doi :10.1088/1742-6596/1073/4/042032*
36. ***Norman K, Stobäus N, Smoliner C, Zocher D, Scheufele R, Valentini L and Lochs H, Pirlich M. (2010).*** *Determinants of hand grip strength, knee extension strength and functional status in. cancer patients Clin. Nutr. 29 586–91.*
37. ***Porta M., Pilloni G., Corona F., et al (2018).*** *Relationships between objectively assessed functional mobility and handgrip strength in healthy older adults. European Geriatric Medicine.;9(2):201–209. doi: 10.1007/s41999-018-0025-7.*
38. ***Cruz-Jentoft A.J, Baeyens J.P, Bauer J.M, Boirie Y, Cederholm T, Landi F, Martin F.C, Michel J, et al., (2010).*** *Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing;39(4):412-23. doi: 10.1093/ageing/afq034.*
39. ***Wander PL, Boyko EJ, Leonetti DL, McNeely MJ, Kahn SE, Fujimoto WY (2011).*** *Greater hand-grip strength predicts a lower risk of developing type 2 diabetes over 10 years in leaner Japanese Americans. Diabetes Res Clin Pract. 92(2):261-4. doi.org/10.1016/j.diabres.2011.01.007*
40. ***Leenders M, Verdijk LB, van der Hoeven L, Adam JJ, van Kranenburg J, Nilwik R, et al (2013).*** *Patients with type 2 diabetes show a greater decline in muscle mass, muscle strength, and functional capacity with aging. J Am Med Dir Assoc. 14(8):585-92. .doi.org/10.1016/j.jamda.2013.02.006.*
41. ***Åström M.J, Bonsdorff M.B , Salonen M.K, Kajantie E, Osmond C, Eriksson J.G 2021).*** *Glucose regulation and grip strength in adults: Findings from the Helsinki Birth Cohort Study. Archives of Gerontology and Geriatrics 94 (2021) 104348. https://doi.org/10.1016/j.archger.2021 .104348*