EFFECT OF AGE ON HAND GRIP STRENGTH AND ITS CORRELATION WITH FUNCTIONAL PERFORMANCE IN OTHERWISE HEALTHY ELDERLY

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Abstract

Objective: To assess the effects of age on handgrip strength (HGS) and physical functional performance of otherwise healthy elderly people.

Method: Elderly individuals of more than 60 years of age were recruited for the study. Elderly subjects (n = 36; 66.69±4.8 years) were evaluated for Hand Grip Strength (HGS); six-minute walk test (6MWT) and Timed Up and Go Test (TUG) were taken for physical activity assessment. HGS was measured by hydraulic JAMAR dynamometer.

Results: A weak but significant correlation between the hand muscle strength and physical activity was observed. HGS correlated significantly with both 6MWT *($p \leq 0.05$)* and TUG ($p = 0.027$).

Conclusion: HGS is a reliable alternative to infer the correlation of muscular strength and functional performance measures for healthy elderly population

Keywords: Elderly, muscle strength, functional performance measures, Hand grip strength, 6MWT, Timed up and go test, functional capability

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DOI: 10.48047/ecb/2023.12.si5a.0604

INTRODUCTION

Ageing is a process which occurs naturally as we grow older and is accompanied by changes (1). These changes are multifactorial and progressive in nature and a few of these changes act adversely on functional aspects of the body (2). These ageing constructs are not only anatomical but also physiological, metabolic and functional. These factors cause a decline in various metabolic processes (3). It is evident that several dysfunctions and pathologies prevalent in geriatric population tend to compromise the functionality, independence level and most importantly their quality of life (4).

As ageing progresses there is increase in body fat with consecutive loss of muscle mass and skeletal tissues, followed by deterioration of function and most importantly mobility (both gross and fine motor) (2- 4). All the factors responsible for maintenance of muscular strength like neurological, hormonal muscular and environmental mechanisms are on a decline (2-5). Hence, the elderly experience a drastic fall in the quality of strength generated. This decrease in strength leads to deterioration in the quality of functional tasks performed. Both upper and lower extremity tasks are affected most, hampering their activities of daily living (ADLs) to a large extent (1,4).

In clinical practice the Hand Grip Strength (HGS) is considered a reliable indicator of general body strength and power (6). HGS is also used as an effective predictor of global strength and functional performance. A few studies have shown non-significant correlation between HGS (7,8) and functionality (9). Physical fitness and functional status, the two majorly affected factors, are quantified by various methods in the elderly population. Several studies have inferred that more the decline in health status, higher is the negative impact on performance of the ADLs and their task performance ability (10,11,12).

When executing functional tests, whether in elderly or younger population, the postural muscles are efficiently engaged, usually the trunk and lower extremity stabilizing muscles. The performances accomplished by these muscles are achieved by the ability to generate strength in a given set of test time (type I fibers). Whereas HGS evaluates peak muscle strength generated by fatigue resistant upper extremity muscles (fast contraction – type II fibers). Functional performance is usually evaluated by the tests that involve displacement and mobility of body and postural transfer. Submaximal functional performance is commonly measured by Six minute walk distance test (6MWT) which evaluates distance travelled by an individual in 6 minutes and is a reliable indicator of cardiorespiratory ability of an individual for activities that require displacement of the body.(7)

The Timed Up and Go test (TUG) indicates the functional mobility of geriatric population. The performance in TUG is related to gait, postural changes during the inevitable act of walking, which is assessed by evaluating the time taken in completing the test (13).
Reproducibility of HGS and functional performance in geriatric population is still under question and there exists a research gap between relation of HGS and functional independence in the elderly (14). The objective of our study was to verify the coalition between HGS and sub-maximal functional capacity during body excursions and mobility in otherwise healthy geriatric population.

SUBJECTS AND METHODS

This research act is an observational study with a cross sectional research design. Ethical approval was obtained from the Institutional Ethics Committee. The subjects targeted were recruited from the geriatric population from the state of Punjab and were in the age group of 60- 75 years. The subjects were targeted using social media flyers and advertisements. The inclusion criteria for the study were designed as strict norms for age (>60 years), individuals showing dependence in functional activities, decrease in muscle strength not due to any pathological background, willing to participate with written consent and without any orthopedic disability. Individuals excluded were those who demonstrated independence or exhibited some physical symptoms arising from chronic diseases. Also, any recent post-operative condition was excluded from the study.

Sociodemographic and clinical variables were also taken into consideration, major interest being on gender, age, height, weight, BMI, level of education, recent health history, lifestyle, social and occupational status.

Level of physical activity is an important aspect which defines many aspects of ageing and was assessed by The International Physical Activity Questionnaire (IPAQ) – short form (15). Short version of IPAQ has 7 questions and the information derived is used to assess the level of physical activity in terms of work, means of transportation, domestic activities, activities of recreation, sports and/or leisure and time spent for sitting (16). The final result is classified as how sedentary, active and very active the individuals are (17).

1. Assessment

To be certain of proper implementation of the evaluation protocol, the data collection was done with strict vigilance. The initial interview as well as tests were conducted on recruited individuals at old age home centers in various cities of Punjab from July 2019 to December 2019. The handgrip strength and functional performance were assessed along with other tests.

3.1 Hand Grip Strength (HGS)

JAMAR Portable hydraulic dynamometer was used to assess the handgrip strength. The evaluation results were verified in different sitting postures, with patients sitting with and without armrest and backrest (18). Other variables employed for measurement of HGS were: Shoulder abducted and in neutral rotation, elbow in 90 degrees of flexion, forearm in neutral position and wrist in between 0 – 30 degrees of flexion/ extension and in between 0 – 15 degrees of ulnar deviation. Before the actual evaluation, a simulation was conducted for the patients to familiarize them with various features of the test. Patients were kept motivated throughout the test with standardized verbal commands. Individuals were asked to sit for the test and were made to perform maximum contraction using the dominant hand. An average of three repetitions were taken as the final value for HGS (14). A 30-second rest interval was given in between each repetition. There are various factors which could hinder the establishment of normal HGS, mainly factors like age, hand dominance, anthropometric characteristics and gender (19).

3.2 Six Minute Walk Test (6MWT)

6MWT was conducted on participants as per the recommendations of American Thoracic Society (20). A thorough assessment of the blood pressure (BP), peripheral Oxygen saturation (SpO2), Borg's RPE, heart rate (HR) and respiratory rate (RR) was done. Subjects were then instructed to walk along a hallway measuring 30 meters for a period of 6 minutes. The individuals being monitored by pulse oximeter were instructed to walk as fast as possible without running. The evaluator followed the walking participant throughout the test. With the passage of every minute, the participants were motivated with a set of pre-established commands. Individuals were allowed to rest in between if they felt tired and could even stop the test midway, as and when they felt uncomfortable during the walk. Most importantly, the timer was not stopped during the rest periods. After completion of 6 minutes, participants were asked to stop and the distance walked by them was measured. Post-test assessment was done for BP, SpO2, HR, RR and RPE (21)

3.3 Timed Up and Go test

This test entitled the participants to walk a distance of 3 meters. Subject was made to sit on a chair with backrest before the start of test. Then on a verbal command the subject was asked to get up from the chair without taking hand support and was asked to walk 3 meters, on reaching the end point he had to take a turn and walk the distance back to the chair and sit again (11). The time is measured in seconds, with the help of a start watch, which was turned "ON" as soon as the subject got off from the chair and was turned "OFF" when his back resumed support with chair's backrest. A practical demonstration was given to the subjects before they were actually put on the test to familiarize with the task to be performed (22).

2. Statistical analysis

Mean and standard deviations were taken as expressions of parametric numerical data.

Pearson's Correlation coefficient was used to verify the association between HGS AND the 6MWT and TUG physical function tests. For comparing the variables between tests, the student's t-test was employed for dependent samples. Level of significance was fixed at $p \leq 0.05$.

RESULTS

TABLE 5.1 represents the characteristics of sample population studied. The participants were in the age group of 60-75 years. Out of the total participants 58.33% were re-employed post retirement and 41.67% were doing nothing. The elderly subjects were grouped as inactive or active depending on the IPAQ questionnaire. A set of subjects was classified as minimally active, on the basis of physical activity exhibited in any of the following patterns: 3 or more days/week of vigorous activity for 20 min/day, 5 or more days per week of moderate intensity exercise for 30 min/day or 5 or more days/ week of combined activity. Any person who did not meet any of the above categories was grouped as an inactive elderly. None of the participants were in health enhancing physical activity (HEPA) category.

Table 5.1 Characterization of sample population (n = 36, healthy elderly)	
QUANTITATIVE VARIABLES [Mean (SD)]	
Age (years)	66.69 (4.84)
Height (mts)	1.7 (0.84)
Weight (kg)	76.85 (14.4)
BMI (kg/m^2)	29.9 (5.26)
QUALITATIVE VARIABLES [N (%)]	
Gender	
Male	6 (16.67)
Female	30 (83.33)
Activities	
Occupation	21 (58.33)
No job	15 (14.66)
Lifestyle	
Socially active	26 (72.22)
Leisure	10 (27.77)
Physical activity [N (%)]	
Exercise/ walk	29 (80.55)
Intense exercise	7 (19.44)
IPAQ classification {N (%)}	
Inactive	4 (11.11)
Minimally active	32 (88.88)
HEPA	0
Abbreviations: BMI = Body mass index, IPAQ = International Physical Activity Questionnaire, HEPA: Health enhancing Physical Activity	

Table 5.2 Results of Functional Performance Measures and hand Grip strength (HGS)	
Tests	Mean ± SD
HGS (kgf)	30.22 (± 8.36)
6MWT(m)	455.17 (± 90.41)
TUG (s)	6.89 (± 1.6)
Abbreviations:: HGS = Hand Grip Strength, 6MWT = 6 Minute Walk Test, TUG = Timed Up and Go Test	

Table 5.3 Shows the analysis of variables pre and post 6 MWT which were taken in for assessing the patient health status around the test			
Variables	**Pre-test variables Mean ± SD**	**Post-test variables Mean ± SD**	**p- value**
SpO2	97 ± 1.84	97.68 ± 1.20	**0.010**
HR	77.15 ± 10.68	82.5 ± 10.62	**0.004**
Borgs RPE	9.94 ± 2.48	10.78 ± 2.58	**0.041**
RR	17.5 ± 2.69	20.56 ± 3.26	**0.000**
Abbreviations: SpO2: Saturation of partial pressure of oxygen, HR: Heart Rate, RR: Respiratory rate, Borgs RPE: Borg's Rating of Perceived Exertion			

Table 5.4 displays the association between HGS, 6MWT scores (distance travelled in meters) and TUG scores (time of displacement measured in seconds). Pearson's correlation coefficient was used to evaluate correlation, which revealed that there is weak significant correlation between muscle strength and functional capacity of an elderly individual, the results being deduced on basis of functional performance measures.

Table 5.4 Correlation between HGS and 6 Minute Walk Test		
Tests	**Handgrip strength**	
	r	p
6MWT	0.324	**0.05**
TUG	-0.385	**0.027**
Abbreviations: 6MWT= 6-minute walk test, TUG = Timed up and go test, r = Pearson correlation, p = significance level		

DISCUSSION

This evaluation done on elderly individuals, aimed at finding the correlation between muscle strength, represented by Handgrip strength and the functional capability of individuals, represented by scores of 6MWT and TUG tests. The Pearson's correlation coefficient revealed that a statistically significant correlation existed between the above variables, although the significance was weak. It was verified that in individuals with higher HGS the distance travelled in 6MWT was higher and the TUG test revealed that the time taken for displacement of individuals was less.

A study done on geriatric males and females by Lenardt *et al*, revealed a direct relationship between less physically activity and a decrease in muscle mass, thereby a higher prevalence of physical limitations and disability was observed in the group (9). Similar results were observed in a study by Martin *et al*, which revealed the effects of a sedentary lifestyle or low physical activity on physiological changes in muscle mass and strength. This alteration in physiological parameters caused a decline in fitness levels and decreased independence, causing decreased functionality in the elderly (23).

Association between BMI and HGS has also been studied in the elderly population (24). Bassi *et al*, analyzed elderly individuals for BMI and HGS. The study revealed that with ageing, a raised BMI can be the cause for a decrease in strength. There was a limitation in their study as the results of participants were analyzed against already established normative values for this age group, resulting in higher cut off points, which affected their final evaluation (25,26). Majority of studies are conducted on frail elderlies suffering from comorbidities, requiring hospitalization, therefore, on comparison with established normative values, a higher significance is recorded during final evaluation. Any indulgence in social, leisure activities along with physical active lifestyle also promotes development of higher muscular strength (HGS) which correlates with good physical fitness. All these factors give good results in physical performance measures when performed in geriatric population. Even the leisure and normal independence level of ADL also contributes to the above outcomes (27,10).

The present study reported mean HGS value in 36 elderly individuals as 30.22 kg (± 8.36). European Working Group on Sarcopenia in Older People (EWGSOP) has redefined the cutoff points related to sarcopenia, which are based through HGS results, for males as <27kg and <16 kg for females. Based on these values sarcopenia was not present in the elderly subjects of the study. Lenardt *et al*, in a study have proved that frailty in elderly is closely related to the cut off points which also are important predictors of disability, morbidity and mortality in frail elderly population (9).

The physical functional performance is the next category of aspects, which are affected in elderly population. When the sample of this study was evaluated for functional performance measures, 6MWT yielded the distance measurement of 455.17 (±90.41) meters in the elderly population. According to another research by Andrade *et al*, the evidence withholds certain formulae for prediction of expected distance walked during 6MWT by a specific population, based on their demographic characteristics (28). Besides, it is a proven fact that healthy individuals can walk more distance in 6MWT than unhealthy individuals, wherein for healthy individuals the range is 400 – 700 meters and for unhealthy individuals it can be as low as < 300 meters; also being associated with higher probability of mortality (21).

On the other hand, TUG results of our study sample showed mean of 6.89 seconds (±1.6). Various studies are present in literature that have shown varying timelines taken by elderly population for performing the TUG test. Rodrigues *et al*, presented that a time level up to 10 seconds was considered to be normal, impaired performance was classified when time taken was between 10.1 – 20 sec, while those who took more than 20.1 sec were classified as a high risk elderly for fall (29). A striking point was revealed by Zaza *et al*, revealing that healthy functionally independent elderly people were able to perform TUG near the normative reference values suggested for this test (22,30).

Scrutinizing the results of the present study, we can infer that computation of HGS can be related to physical work done by otherwise healthy elderly for assessing the functional aspects. Literature holds many evidences, which show correlation between HGS and functional performances in the elderly. In a study by Wis`niowska-Surlej *et al*, correlation between HGS and motor task performance was insignificant. Motor tasks taken into consideration were both gross motor and fine motor tasks, which included activities like walking, stair climbing, unlocking-locking, writing etc (11). Likewise, in another study Bohannon RW., revealed the reliability of HGS as an indicator of independence levels and day to day functional activities (10). The level of independence was evaluated by Barthel Index and Lawton scale, which provide information through scores about specific ADLs, which include implementation of both gross and fine motor strength (26) .

The need of the hour is to develop an easily applicable, evaluated and reliable tool for interpretation of functional status in the elderly. Literature holds very little evidence for the same variables and correlations studied in this research. The current study was planned on methodological accuracy, elements of performance measures along with exact inclusion/ exclusion criteria. Major limitation of our study was a small sample size, with emphasis on a single gender. These limitations results drawn pave a path for future comprehensive research in this field by recruiting a bigger sample, along with gender stratification and a more homogeneously distributed sample.

CONCLUSION

The present analysis may conclude that in elderly population HGS is related to functional efficacy and mobility regardless of gender stratification. Assessment of the peripheral muscle strength can be easily done by measuring HGS in elderly individuals and it can be used as a fast and inexpensive method of functional assessment, with a direct link to the submaximal functional capacity and body mobility. The sample included in the study had a mean age of 66.69 (± 4.84) years, which indicates that early interventions can be planned for this population and if such evaluation is made at an early stage, it can help prevent disability and mortality in the elderly.

SIGNIFICANCE OF THE STUDY

Hand grip strength (HGS) is an important indicator of functional performance in the elderly. Good HGS can be correlated with reduced incidence of falls. Hence, rehabilitation exercises for improving hand grip strength can enhance functional performance and reduce recurrent falls in the elderly.

ACKNOWLEDGEMENT

The authors acknowledge their sincere thanks to the participants of the study.

Conflicts of interest

There are no conflicts of interest related to this study

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