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Effect of hand grip strength and hand dexterity on upper extremity performance in activities of daily living in elderly: A pilot study

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Abstract
Background: Aging is associated with a decline in handgrip strength (HGS) and dexterity, both essential for upper extremity activities of daily living (ADLs). Reduced function in these areas increases caregiver dependence, frailty, and decreases quality of life. The specific role of hand strength and dexterity in upper limb performance remains under explored.
Methodology: This cross-sectional study involved community-dwelling individuals aged 60 and above. HGS was measured using a hand dynamometer, dexterity with the 9-Hole Peg Test, and upper extremity function using the Upper Extremity Functional Index. Correlation and regression analyses examined relationships among variables.
Results: HGS and dexterity were significantly correlated with ADL performance. Higher scores were associated with greater independence. HGS was a stronger predictor than dexterity. Individuals over 80 showed a marked decline in both.
Conclusion: Routine assessment and early intervention targeting HGS and dexterity can help preserve independence, reduce disability risk, and improve quality of life in older adults.

Keywords: Handgrip strength, dexterity, upper extremity function, frailty, sarcopenia, quality of life

Introduction
Hand strength is a crucial factor in maintaining the independence and quality of life of elderly individuals. A decline in hand strength can affect their functional abilities, lead to dependence in daily activities, and increase the risk of disabilities [1]. Handgrip strength is extremely important to perform daily life activities such as holding object, using a hand railor bus support, carryout domestic tasks, self-care activities, that is to maintain functionality and independence [2]. Among the various tests of muscle function, handgrip strength measurement has gained popularity as a non-invasive method for assessing upper limb muscle strength [3]. In healthy individuals, hand grip strength is primarily influenced by age and gender [4]. Handgrip strength is a commonly used, simple, and cost-efficient tool for evaluating muscle strength. In contrast, functional performance assessments involve tasks that require continuous interaction between the individual and their surrounding environment [5].
Handgrip strength tends to decline with age, especially in individuals over 80. A study involving 8,342 aged 46 to 102 revealed a gradual decrease in grip strength from age 46 to 85, followed by a more pronounced decline after age 85 [6]. People aged 80-89 have handgrip strength that is approximately 37% lower compared to individuals aged 30 [7]. Handgrip strength in individuals aged 80-89 is 37% lower than that of 30-year-olds [8]. Handgrip strength is essential for older adults to carry out activities of daily living (ADLs), which typically require a minimum grip strength of at least 9 kg [9]. Additionally, handgrip strength serves as a valuable indicator for assessing the overall health of older adults and is useful in predicting the risk of disability and mortality [10].
The handgrip dynamometer is the most widely used instrument for measuring muscle strength in both clinical practice and research. Decreased handgrip strength (HGS) is associated with a higher risk of cardiometabolic conditions, disability, disease, and premature death. Because muscle strength is a more accurate indicator of negative health outcomes than muscle mass,

lower HGS values serve as a marker of declining health-related fitness. Consequently, the Foundation for the National Institutes of Health (FNIH) recommends the HGS test for diagnosing sarcopenia, and it has recently been adopted as a primary screening tool in the updated guidelines of the European Working Group on Sarcopenia in Older People (EWGSOP) [11].

Dexterity refers to the skilled and efficient movement of the hands to perform tasks that involve turning, placing, or handling objects and is essential for carrying out daily activities and work-related tasks, and it is frequently impacted by hand injuries. When considering hand function, dexterity can be classified as either static or dynamic. Static dexterity such as using a clenched fist to strike like a hammer is non-prehensile and does not involve intricate manipulation. In contrast, dynamic dexterity includes both prehensile actions (like a power grip) and precise handling, which involves manipulating objects with the thumb and index or middle fingers. Additionally, dexterity can be further divided into manual dexterity and fine finger dexterity [12]. Dexterity encompasses voluntary hand movements aimed at completing specific tasks and is a vital measure of neuro motor function, as it relies on the integration of both motor and sensory systems. Moreover, dexterity serves as an important indicator of a person's ability to maintain independence in daily living activities [13]. It is a highly developed skill in humans that allows for a broad range of purposeful, object focused movements. However, this capability often diminishes with age, potentially impairing the performance of daily activities and leading to a loss of independence [14]. Hand dexterity plays a crucial role in upper limb function and significantly affects an older adult's ability to carry out Activities of Daily Living (ADLs), including dressing, grooming, eating, and handling household tasks. As hand function declines with age, individuals may become more dependent on caregivers, which can negatively impact their overall quality of life [15]. A decline in hand dexterity can make Activities of Daily Living (ADLs) more difficult. Everyday tasks like buttoning a shirt, opening jars, or using utensils may become progressively harder, increasing reliance on caregivers and diminishing quality of life. As such, preserving hand function is crucial for maintaining independence and improving overall well-being in older adults [16]. The upper extremities (UE) are essential for performing Activities of Daily Living (ADLs), as demonstrated by numerous studies. Manual ability is a critical indicator of an individual's level of independence. As the population ages, a growing number of older adults may develop sensorimotor impairments that impact UE function, thereby affecting their ability to carry out ADLs independently. Effective execution of manual tasks relies on several key components, including motor coordination, manual dexterity, muscle strength, and sensory function in the upper limbs [17].

Materials and methods

A cross-sectional study was carried out among elderly people living in the community who are older than 60 years in the AJ Urban Health Centre in Mangalore. The sample size of 25 participants was calculated based on a previous study by Chiungu Ju Liu *et al*., which found a correlation of 0.6 between hand dexterity and upper limb function. The confidence level was set at 95% and the power at 90%. Participants were selected using a convenaient sampling method. The study was carried out over a period of one year. Approval for the study was obtained from the Institutional Ethics Committee. People who wanted to take part in the study were given a sheet that explained the process, and their consent was obtained before they joined.

The inclusion criteria for the study are: people of both genders who live in the community, are 60 years of age or older, understand and follow instructions, and are willing to join the study.

People will not be included if they have had recent fractures or surgeries on their arms or legs, have musculoskeletal conditions like arthritis, have cognitive problems such as Alzheimer's disease, or have neurological issues like stroke or Parkinson's disease. Also, those who are visually impaired are not allowed to participate in the study.

Procedure

Participants who meet the inclusion criteria will be included in the study. A short explanation about the testing process will be given to all participants. Informed consent will be obtained from those who meet the inclusion criteria. A first check-up including demographic data will be done. Participants will be assessed for hand grip strength using a hand-held dynamometer, hand dexterity using the 9-hole peg test, and upper limb function during daily activities using the Upper Extremity Functional Index. All three tests will be analyzed to find out how hand grip strength and hand dexterity affect upper limb performance in daily living among elderly people living in the community.

Outcome measures

Hand-held dynamometer, Nine-hole peg board &Upper extremity functional index scale

Hand-held dynamometer

The dynamometer is placed on a flat, stable surface. Before each use, reset the dynamometer to zero by turning the dial to zero and pressing the zero reset button if available. Check that the dynamometer is properly calibrated according to the manufacturer's instructions. Tell the person to hold the handle of the dynamometer as per the testing instructions, such as keeping their elbow at a right angle and their forearm straight. Ask the person to grip the handle as hard as they can for a few seconds. Read and write down the strength shown on the dial or digital display. If needed, repeat the test to get an accurate or average reading.

Hole peg board test

Place the pegboard horizontally in front of the participant. Make sure the holes are facing upwards and easily accessible. Tell the participant about the task. They will need to pick up each peg, one at a time, from a container and put them into the holes on the pegboard as fast as they can. Demonstrate the task to make sure the participant understands. Use a stopwatch to time how long the task takes. Record the time it takes to complete the task. Depending on the protocol, the test might be done multiple times to get an average score. The result is usually the time taken to complete the task. Faster times show better hand function and dexterity. There are different versions of the test, such as using the nondominant hand, adding obstacles, or changing the shape of the pegs, based on the specific needs of the test.

Upper extremity function index

The Upper Extremity Functional Index (UEFI) is a tool used to evaluate functional Limitations in people with upper limb musculoskeletal problems. It is a self-reported questionnaire that is easy to use. The patient answers each question by selecting a number that best describes how difficult they find the task. Each question scores between 0 and 4, where 0 means extreme difficulty and 4 means no difficulty. The total score is the sum of all item scores. The UEFI has 20 questions and a possible total score ranging from 0 to 80, with 0 being the lowest functional status and 80 the highest. A change of 9 points is considered clinically significant. The total score is the sum of all 20 question scores, with the highest score being 80 and the lowest 0. A lower score means the person reports more difficulty with daily tasks due to their upper limb condition**.**

Result

Older adults aged 65years and above were recruited for the study. Participants were screened based on the inclusion and exclusion criteria. Using the convenience sampling technique, a sample size of 20 was estimated. The statistical analysis was done using SPSS 23.0. Categorical variables were presented using frequency and percentage. Numerical variables were presented using mean and standard deviation. Correlation was done using Karl Pearson's Correlation coefficient. A p value <0.0 was considered statistically significant. Among 20 participants (50% under 70 years, 50% aged 70 or older; mean age 70.9 ± 7.49 years), a strong negative correlation was found between the Upper Extremity Functional Index (UEFI) and grip strength measured by a dynamometer for both the right (r = -0.840, *p*<0.001) and left hand (r = -0.843, *p*<0.001), indicating that higher self-reported function was associated with lower grip strength. Additionally, a very strong positive correlation was observed between UEFI and the 9-Hole Peg Test time for both right (r = 0.945, *p*<0.001) and left hands (r = 0.947, *p*<0.001), suggesting that greater perceived function was linked to longer completion times.

Tables and Figures

Table1: Showing age classification

		Frequency	Percent
Age	<70 years	10	50.0
	>=70 years	10	50.0
	Total	20	100.0

Table 2: Showing gender distribution

		Frequency	Percent
Gender	Female	7	35.0
	Male	13	65.0
	Total	20	100.0

Table 3: Showing correlation between Upper Extremity Functional Index and right hand held dynamometer

		Hand Held Dynamometer (kg)
		Right
upper extremity functional index	r value	-.840**
	p value	.000
	N	20

Table 4: Showing correlation between Upper Extremity Functional Index and left hand held dynamometer

		Hand held dynamometer (kg)
		Left
Upper Extremity Functional Index	r value	-.843**
	p value	.000
	N	20

Table 5: Showing correlation between Upper Extremity Functional Index and the right-hand 9-Hole Pegboard Test

		9 Hole Peg Board Test(sec)
		Right
Upper Extremity Functional Index	r value	.945**
	p value	.000
	N	20

Table 6: Showing correlation between Upper Extremity Functional Index and the left-hand 9-Hole Pegboard Test

		9 Hole Peg Board Test(sec)
		Left
Upper Extremity Functional Index	r value	.947**
	p value	.000
	N	20

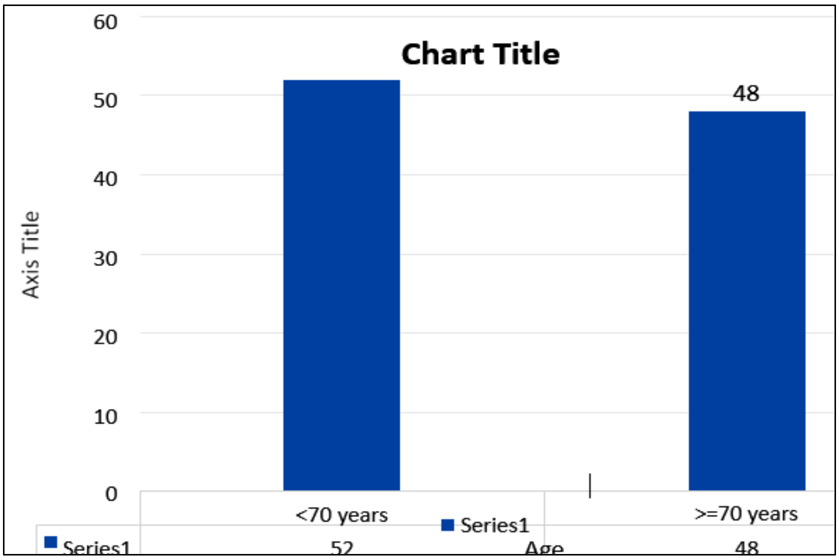

Fig 1: Representing age classification

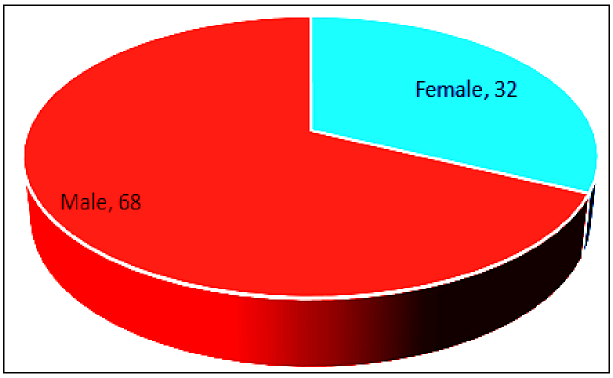

Fig 2: Representing gender distribution

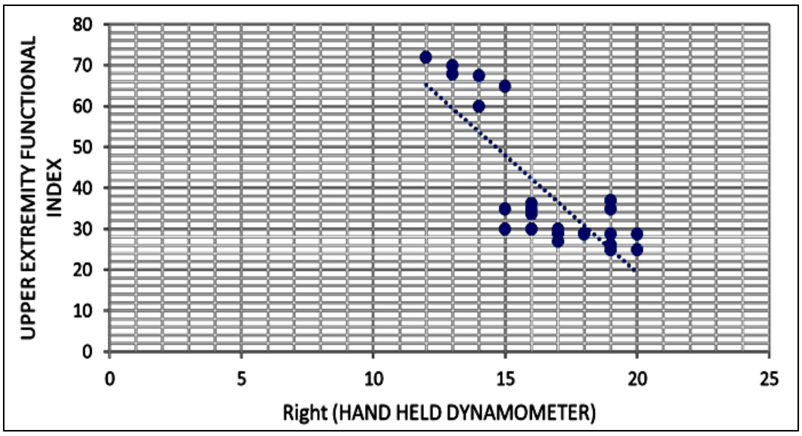

Fig 3: Representation of Stork Balance Test (Seconds) in roller skating children with and without ankle sprain history

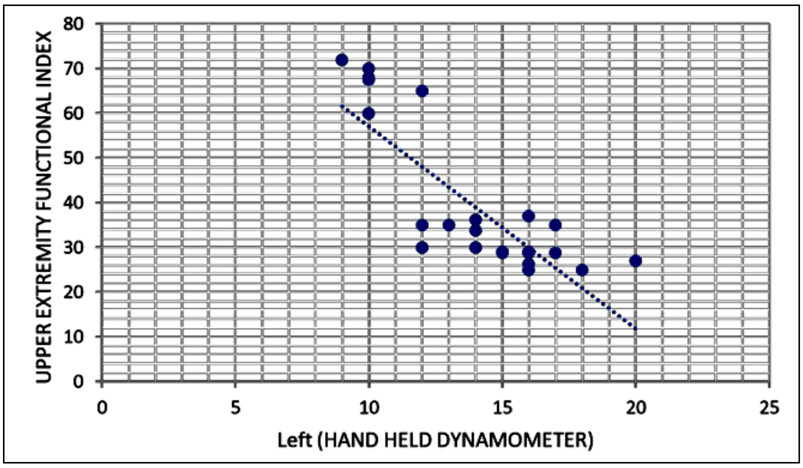

Fig 4: Representing correlation between Upper Extremity Functional Index and left hand held dynamometer

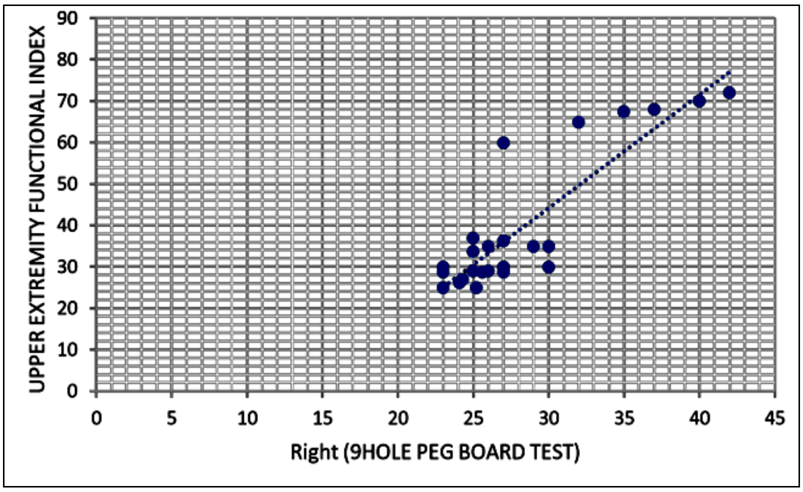

Fig 5: Representing correlation between Upper Extremity Functional Index and the right-hand 9-Hole Pegboard Test

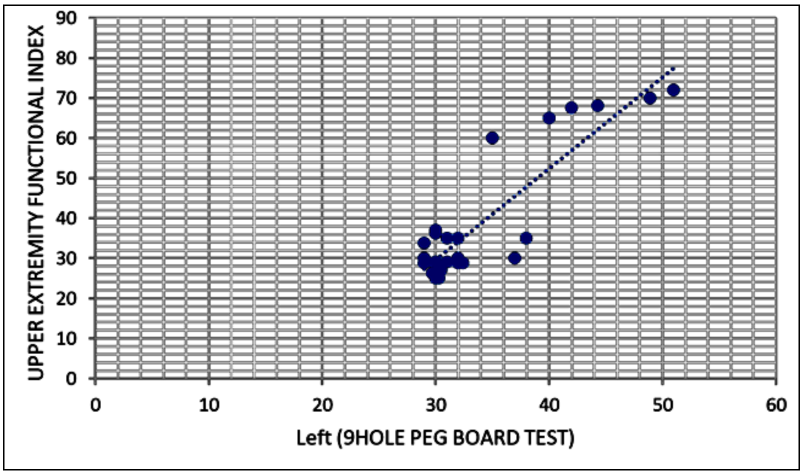

Fig 6: Representing correlation between Upper Extremity Functional Index and the left-hand 9-Hole Pegboard Test

Equation

On the basis of the study conducted by Chiungu Ju Liu *et al*., Correlation between hand dexterity and upper extremity function was observed as 0. 6, Considering confidence level of 95% and power of 90%, estimated sample size is 20

Formula: N=[Zα+Zβ)/C]2 +3

Where, C=0.5*ln[1+r/1-r] Confidence level=95%, Za=1.96 Power=80%Zβ=0.84
r=-0.6 ln=logarithm

Discussion

This study investigated the relationship between upper extremity function, grip strength, and manual dexterity using the Upper Extremity Functional Index (UEFI), hand-held dynamometer, and 9-Hole Peg Test. Results revealed a strong negative correlation between UEFI scores and grip strength in both the right (r = -0.840, $p<0.001$) and left hands (r = -0.843, $p<0.001$), indicating that individuals with lower upper limb function also exhibited reduced muscular strength. Additionally, a very strong positive correlation was observed between UEFI scores and 9-Hole Peg Test completion times for the right (r = 0.945, $p<0.001$) and left hands (r = 0.947, $p<0.001$), suggesting that decreased upper extremity function was associated with impaired fine motor coordination and prolonged task performance.

Our findings are alaign with Stratford *et al*. (2001), who first validated the UEFI and reported its effectiveness in evaluating upper limb disability, particularly its strong correlation with physical performance measures [18]. similarly Chesworth *et al*. (2014), who confirmed the reliability and responsiveness of both the original and Rasch-refined versions of the UEFI, reinforcing its utility in clinical and research settings [19]. Recent work by Bejer *et al*. (2025) validated the Polish version of the ULFI, demonstrating strong construct validity and responsiveness in patients with upper limb musculoskeletal disorders [20].

The observed inverse relationship between functional scores and grip strength aligns with the findings of El-Gohary *et al*. (2019), who noted that reduced upper limb strength is commonly associated with lower functional capacity in individuals with upper extremity impairments [21]. Similarly, Alotaibi *et al*. (2020) highlighted that hand dexterity, as measured by the 9-Hole Peg Test, significantly correlates with self-reported functional scores in neurological and orthopedic populations [22]. Taken together, our findings emphasize the importance of assessing both objective and subjective measures when evaluating upper limb performance. The consistent relationship between UEFI scores, grip strength, and manual dexterity suggests that comprehensive rehabilitation programs targeting both strength and fine motor skills may improve functional outcomes in individuals with upper limb impairments.

Conclusion

This study reveals interesting relationships between upper extremity function, grip strength, and dexterity. A strong negative correlation between the Upper Extremity Functional Index (UEFI) and grip strength suggests that higher UEFI scores are linked to lower grip strength, possibly due to greater reliance on coordination rather than strength. Additionally, the very strong positive correlation between UEFI and the 9- Hole Pegboard Test completion times for both hands indicates that individuals with higher UEFI scores tend to take longer to complete dexterity tasks, possibly due to more precise or deliberate movements. These results highlight the importance of focusing on hand grip and dexterity, into geriatric health programs. This can improve upper extremity function, boost ADL performance, and reduce functional decline, enhancing quality of life in the elderly

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