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Aging On Hand Function: Investigating The Effectiveness Of Proprioceptive Training On Hand Grip In Geriatric Population

Pooja Saikia

(PhD Research Scholar, Assam DownTown University)

Assistant Professor, Univeristy of Science and Technology, Meghalaya

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Abstract: *Handgrip strength measurements are feasible for older adults. Also, they are a reliable indicator of vitality, physical function, and several risk factors in the aging process. Interventions with proprioception training induce a variety of strength, balance, and endurance improvements. However, the studies related to proprioceptive exercise to improve hand grip, particularly among the geriatric population ,are very limited. Therefore, this study aims to evaluate the effectiveness of proprioceptive training in improving hand grip strength and hand function in the geriatric population. A total of 30 geriatric populations are considered using a simple random sampling technique. The study concludes that the proprioception training program has been found to result in statistically significant enhancements of hand grip strength in geriatric individuals, ultimately improving their ability to perform activities of daily living. Therefore, proprioceptive training is a valuable intervention for promoting the overall well-being and quality of life in the elderly.*

Keywords:*Aging, Hand Grip, Physiotherapy Exercises, Proprioception Training, and Geriatric Population.*

1. INTRODUCTION

The aging process is naturally followed by several multifactorial and progressive changes. Even the elderly presents no changes in the performance of daily living activities (DLAs), the advancing age is associated with decreased mobility and muscle strength. Therefore, the loss of muscle mass and strength contribute significantly to physical incapacities in aging. Grip strength is a common measure of muscle strength that is sensitive to age-related changes and changes in biological functioning [1-5]. Increased physical activity and resistance exercise improve muscle strength and function even in older people with severe disability. An easily applicable measure of muscle strength is a handgrip strength (HGS) test. Hand grip strength is a widely used and accessible test that can be measured using a hand dynamometer [6-10].Exercise programs have been shown to be effective in reducing the risk of falling and the rate of falls as they can improve muscle strength, flexibility, balance, coordination,

proprioception, reaction time, and gait. One of the factors associated with aging is also the decline in proprioceptive function. Proprioception plays an important role in the planning of precise and coordinated movements, maintaining balance, and controlling body posture. Thus, proprioceptive training plays a crucial role in enhancing the functional capacity of elderly individuals, particularly in improving balance and reducing the risk of falls [11-15]

Problem statement

Geriatric people need their hand grip strength in various daily activities because when their age increases grip strength tends to decrease due to various factors, including weak hand muscles which can result in an increased risk of falls. Studies have shown a connection between a weak HGS and several negative health consequences, including reduced physical abilities, poor cognitive function, chronic illnesses, and early death. Previous studies investigated the relation between HGS and various factors [16-18]. Despite numerous studies demonstrating a significant relationship between increased age and reduced hand dexterity, few studies have attempted to investigate the effectiveness of proprioceptive training. However, there is a lack of research that has systematically investigated how proprioceptive exercises can improve hand grip in the geriatric population. Therefore, further studies on the content and effectiveness of various proprioceptive exercise programs are needed [19-20]. Thus, to fill this aforementioned gap, the purpose of the present study is to investigate the effectiveness of proprioceptive exercises on the development of hand grip in the geriatric population.

Objectives of a study

The research objectives are specific and measurable goals that outline what the researcher accomplishes within a study. Thus, the objectives of the research study are described below,

- To test the effect of 6 weeks of proprioceptive training in the assessment of handgrip strength in geriatric population
- To assess geriatric participants' baseline hand grip strength and hand function before the intervention.
- To measure the changes in hand grip strength using a hand dynamometer following the proprioceptive training.
- To evaluate the improvement in hand function using the Jebsen Hand Function Test after the training program.
- To analyze the statistical significance of the improvements in hand grip strength and hand function through paired t-tests and effect size calculations.

The manuscript is organized as: The next section presents a detailed review of the literature. Section 3 provides the research methodology, which details the material, data collection, and techniques used. Section 4 presents a detailed analysis of the study findings. Finally, Section 5 summarizes the main takeaways from the study and suggests some avenues for future research.

2. LITERATURE REVIEW

Abeer M. Rahma *et al.* [21] aimed to explore the hand grip strength and proprioception assessment in

individuals with forward head posture. A total of 52 age-matched participants were gathered in this study. By applying unpaired t-test analysis, the comparison between handgrip strength and wrist proprioception between the groups was examined. Findings showed that a significant difference was attained in wrist joint proprioception between groups, whereas no significant difference was found in handgrip strength between groups. Due to the cross-sectional study, the generalizability of the findings might be affected.

Nagwa Ibrahim Rehab*et al.* [22] investigated the effect of hand exercise programs on grip strength, wrist proprioception, and hand function in patients with type 2 diabetic polyneuropathy (DPN). In this study, 40 male patients with type DPN aged from 50 to 65 years were considered for the analysis. By the Jebsen-Taylor Hand Function Test (JTHFT), the grip strength and hand function were evaluated. Compared with pretreatments, the post-treatment showed that there was a statistically significant improvement in all measured outcomes in both groups. However, there was a lack of follow-up to determine the long-term effects of the hand exercise program on HGS, wrist proprioception, and function in patients with type 2 DPN.

Raquel Cantero-Téllez*et al.* [23] examined the proprioceptive training program effectiveness for patients with thumb CMC joint OA.In the study, 52 female patients with thumb CMCJ OA were recruited and were randomly allocated into 2 groups.Then, the differences in characteristics of participants between groups were analyzed using unpaired t-tests and chi-square. The study showed that both the experimental and control groups made both clinically and statistically significant changes in the mean VAS and COPM scores over time. A sample size calculation was not completed prior to the commencement of the study.

Naik S and Nagarwala R [24] intended to analyze the impact of ankle exercise programs and proprioceptive training on the stability and performance of functional activity in the elderly population. A total of 40 participants were involved in this study. The level of significance was analyzed through a Mann-Whitney U test and a Wilcoxon test. The research revealed that after the ankle exercise program and proprioceptive training, there was a significant development in stability and functional activity for the performance of ADLs. However, there was no significant difference between the comparative groups.

Giovanni Esposito*et al.* [25] identified the effectiveness of proprioceptive training to improve the static and dynamic balance among elderly populations.The sample consisted of 30 Italian elderly,and they were randomly divided into two groups. Next, to analyze the differences between the two groups, the independent sample t-test was performed.The findings of a study demonstrated that the 12 weeks of proprioceptive training significantly developed the static and dynamic balance. Additionally, the perceptions of the experimental group were more positive than the other one. However, the generalizability of findings might be affected by the limited size of the sample.

Nimra Arshad*et al.* [26] intended to identify the effectiveness of resistance training with and without finger movement exercised on hand grip strength and hand function in the elderly population. Through the convenient sampling technique, 24 participants were selected. Based on a quantitative analysis, the findings of the study were analyzed. By comparing the pre-and post-treatment values within the treatment and control group, there was a statistically significant difference was found in improving the function of the hand and grip strength.The intervention period of the study was relatively short and no

follow-up was carried on.

Susan Mathews and Anila Paul [27] focused on the impact of task-oriented training on grip strength, hand dexterity, and function among the institutionalized geriatric population. Based on the inclusion and exclusion criteria, 16 institutionalized geriatric participants were recruited. Using the box and block test, gross dexterity was assessed. Among the experimental group, a significant improvement was identified in "gross and fine hand dexterity" and "grip strength". However, only an institutionalized geriatric population was targeted, where the environmental and other confounding factors might be slightly different from a community-dwelling geriatric population.

Masoumeh Eskandarzadeh*et al.* [28] studied the role of handgrip strength in predicting the quality of life in older adults. A cross-sectional analytical study was conducted among 115 older adults who were residing in retirement centers in Guilan Province. Using a two-stage sampling method, participants were selected and analyzed. Finally, the study found that there was a positive and significant correlation between HGS and QOL ($r = 0.54$, $P = 0.001$). The study design was cross-sectional, which limited the abilityto establish a causal relationship between HGS and QOL.

Manchumad Manjavong*et al.* [29] demonstrated the prevalence of low HGS and its predictors among outpatient older adults. Based on a cross-sectional study, research was conducted with 198 patients aged ≥ 60 years at the outpatient in a tertiary care setting.The prevalence of low HGS was 51%, and Median HGS was 17.8 kg and 27.7 kg in women and men, respectively. Furthermore, low HGS was prevalent among older patients in this setting, indicating a high degree of possible sarcopenia. Because of the nature of the study design, the temporal relationship between outcome and exposure couldn't be determined.

Pilar Perez-Ros *et al.* [30] examined the home-based exercise program that focused on proprioception to reduce falls in frail and pre-fail community-dwelling older adults. In the study, a total of 564 community-dwelling people aged ≥ 70 years and over with different frailty phenotypes were considered. Next, to explore the homogeneity of variances for continuous variables, the Levene test was used, and the Kolmogorov-Smirnov test was used to assess normality. According to frailty status, no differences were found functionally independent in the performance of basic and instrumental activities of daily living and mobility. However, the inter-rater reliability was not established among the rating nurses.

3. METHODOLOGY

This study involves 30 geriatric participants aged 63 to 69 who met specific inclusion criteria, such as having hand grip strength below 19 kg for males and 16 kg for females, being conscious, and having no upper limb defects. Exclusion criteria include neurological deficits, recent surgery in the spine or hand, mental decline, and chronic heart disease. The participants undergo a 6-week proprioceptive training program that is conducted five days a week. The program includes isometric exercises that target the wrist and fingers, rhythmic stabilization exercises using a water bottle, and dart-throwing motions involving wrist movements. Hand grip strength is measured using a dynamometer, while hand function is assessed through the Jebsen Hand Function Test, which records the time taken to complete various tasks. Statistical analysis is performed using paired t-tests to compare pre-test and post-test results, and the effect size is determined with Cohen's d. A p-value of less than 0.05 is considered as

significant.

3.1 Participants

Thirty geriatric participants aged 63 to 69 years have been recruited for this study. Inclusion criteria require participants to have hand grip strength below 19 kg for males and 16 kg for females, be conscious, without upper limb defects, and be able to undergo movements. Exclusion criteria include neurological deficits, recent surgery in the spine or hand, mental decline, and chronic heart disease.

3.2 Intervention

The participants are divided into two groups, each receiving different forms of exercise over a 6-week period, with sessions held five days per week. The purpose is to compare the effectiveness of proprioceptive exercises and recreational activities in improving hand function among the elderly.

Group A focused on proprioceptive training combined with conventional physiotherapy. The exercises in this group include;

- **Isometric Exercises:** These exercises involve holding static positions to strengthen the muscles in the wrist and fingers.
- **Rhythmic Stabilization:** Participants perform circular wrist motions while holding a water bottle, completing 10 cycles at various angles.
- **Dart-Throwing Motion:** This exercise involves coordinated wrist movements and simulating the action of throwing a dart to improve control and coordination.

Group B engaged in recreational activities alongside conventional physiotherapy. The activities include;

- **Card Games:** These tasks involve light hand movements and mild cognitive engagement, helping to maintain hand function.
- **Light Physical Tasks:** Participants perform tasks, such as picking up small objects, and mimicking everyday activities, but with less emphasis on targeted hand training.

Both groups follow their specific exercises with the same frequency and duration to confirm that the primary difference between the groups is the type of activities performed

3.3 Outcome Measures

Two primary outcome measures are used such as;

- **Hand Grip Strength:** Measured using a hand dynamometer. Participants are asked to squeeze the dynamometer with maximum effort for 5 seconds, and the average of three readings is recorded for both the dominant and non-dominant hand.
- **Jebsen Hand Function Test:** Assessed various hand functions, including printing, card turning, picking up small objects, stacking checkers, simulated feeding, and moving large cans and weights. The total time to complete these tasks is recorded.

3.4 Statistical Analysis

Paired t-tests compare pre-test and post-test results for hand grip strength and Jebsen Hand Function Test times. Effect sizes are calculated using Cohen's d to quantify the magnitude of the improvements. A p-value of < 0.05 is considered as statistically significant.

4. RESULTS AND DISCUSSION

This section presents the key findings from the study, including improvements in hand grip strength and hand function. The results are discussed in relation to the effectiveness of the proprioceptive training program in enhancing the outcomes among the geriatric participants.

4.1 Participant Demographics

In the study,a total of 30 participants were included, all aged between 63 and 69 years. The participants were selected based on the inclusion criteria of having hand grip strength below the specified threshold, being conscious, without upper limb defects, and within the age group of 60-70 years. The demographics are summarized in Table 1.

4.1.1 Gender Distribution

The gender distribution among the participants was relatively balanced with a slightly higher proportion of male participants.

Table 1: Gender Distribution of Participants

Gender	Number of Participants	Percentage (%)
Male	18	60%
Female	12	40%
Total	30	100%

Table 1 shows that the study sample consisted of 60% male and 40% female participants, providing a balanced gender representation. This distribution ensures that the study's findings were applicable across both genders, enhancing the generalizability of the results within the geriatric population.

4.1.2 Age Distribution

The participants' ages ranged from 63 to 69 years, with the distribution of ages summarized in Table 2. The majority of participants were aged 65 or older.

Table 2: Age Distribution of Participants

Age (Years)	Number of Participants	Percentage (%)
63	2	7%
64	5	17%
65	7	23%
66	4	13%
67	6	20%
68	4	13%
69	2	7%
Total	30	100%

Table 2 illustrates the age distribution of participants, with the majority (63%) aged between 65 and 67 years. This concentration in the mid-to-late 60s confirms that the study's findings are particularly relevant to the age group, which is representative of the geriatric population at risk for hand grip weakness.

4.2 Hand Grip Strength Measurements

Hand grip strength was measured using a hand dynamometer at three different points: pre-test (before the start of the training), mid-test (after three weeks), and post-test (at the end of the six-week training period). The following table summarizes the hand grip strength of each participant at these three points.

Table 3: Hand Grip Strength Measurements (kg)

Participant	Age	Pre-Test	Mid-Test	Post-Test
Dulal Saikia	68	12	13	15
Anindya Sundar Borah	65	11	12	14
Debas Kalita	65	10	11	12
Samir Ahmed	67	8	10	12
Jyotirmoy Sharma	67	7	9	11
Khitap Jyoti Sarmah	65	7	9	11
Harish Kumar Mahanta	63	11	13	14

Debarshi Deka	65	9	11	12
Sarjad Chodhury	67	11	12	13
Pankaj Barman	66	9	12	13
Kunal Patowary	65	11	12	13
Habibul Islam	68	10	12	14
Ramen Hazarika	69	10	12	14
Bhargab Thakuria	69	9	11	12
Pranjal Sharma	64	12	13	15
Pabanmoni Boro	64	9	10	11
Harsha Protim Das	67	11	11	13
Jakir Hussain	67	11	12	14
Saurav Talukdar	64	10	12	13
Tanmoy Thakuria	67	9	10	11
Naba Pathak	66	8	9	10
Jit Sharma	67	10	12	12
Dipankar Roy	66	10	10	11
Rohit Sharma	68	9	11	13
Deepak Deka	68	10	11	12
Jahnu Borgohain	66	9	11	12
Lakkhi Saikia	65	9	11	12
Rupak Bhuyan	64	10	12	13
Pranab Adhikary	64	9	10	11
Bishnu Adhikary	64	9	10	11

Table 3 shows each participant's hand grip strength measurements before, during, and after the training. For example, Dulal Saikia's grip strength increased from 12 kg at the pre-test to 15 kg at the post-test. Similarly, Anindya Sundar Borah improved from 11 kg to 14 kg. Overall, most participants saw an increase of 2 to 3 kg in their grip strength after the training.

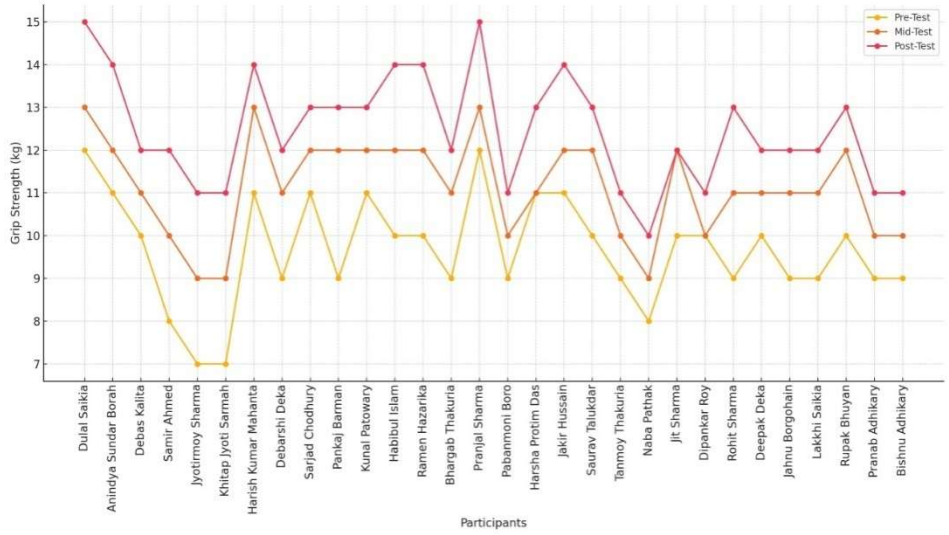

Figure 1: Hand Grip Strength Progression

Figure 1 shows each participant's hand grip strength progression across the pre-test, mid-test, and post-test stages. The graph highlights an overall increase in grip strength from the pre-test to the post-test for most participants, with the mid-test values generally showing intermediate improvements. This trend underscores the effectiveness of the training program in enhancing hand strength over time.

Figure 2: Hand Grip Strength Measurement Process

Figure 2 illustrates the process used to measure hand grip strength in the study participants. The first image shows a participant using a hand dynamometer under supervision, ensuring measurement accuracy and consistency. The second image provides a close-up view of the dynamometer, highlighting the proper hand positioning required for reliable readings.

4.3 Jebsen Hand Function Test Results

The Jebsen Hand Function Test was used to assess the effectiveness of the two different intervention programs on hand function in the geriatric population. Participants were divided into two groups: Group A, which underwent proprioceptive exercises combined with conventional physiotherapy, and Group B, which participated in recreational activities combined with conventional physiotherapy. The test was conducted at three intervals: pre-test, mid-test, and post-test.

Table 4: Jebsen Hand Function Test (Time in Seconds)

Group	S.No	Participant	Age	Pre-Test Time (s)	Mid-Test Time (s)	Post-Test Time (s)
Group A	1	Dulal Saikia	68	40	35	30
	2	Anindya Sundar Borah	65	40	35	30
	3	Debas Kalita	65	40	40	30
	4	Samir Ahmed	67	50	45	40
	5	Jyotirmoy Sharma	67	50	50	45
	6	Khitap Jyoti Sarmah	65	45	40	40
	7	Harish Kumar Mahanta	63	35	30	25
	8	Debarshi Deka	65	50	50	45
	9	Sarjad Chodhury	67	40	40	35
	10	Pankaj Barman	66	50	50	45
	11	Kunal Patowary	65	45	40	35
	12	Habibul Islam	68	35	35	30
	13	Ramen Hazarika	69	40	35	30
	14	Bhargab Thakuria	69	50	45	45
	15	Pranjal Sharma	64	35	30	25
Group B	1	Pabanmoni Boro	64	40	35	30
	2	Harsha Protim Das	67	50	45	40
	3	Jakir Hussain	67	50	50	45
	4	Saurav Talukdar	64	40	30	30
	5	Tanmoy Thakuria	67	45	35	30
	6	Naba Pathak	66	45	35	30

	7	Jit Sharma	67	40	40	30
	8	Dipankar Roy	66	35	35	30
	9	Rohit Sharma	68	50	35	40
	10	Deepak Deka	68	50	35	40
	11	Jahnu Borgohain	66	45	40	35
	12	Lakkhi Saikia	65	40	35	30
	13	Rupak Bhuyan	64	35	30	25
	14	Pranab Adhikary	64	35	30	25
	15	Bishnu Adhikary	64	40	35	30

Table 4 provides the results of the Jebsen Hand Function Test for two groups of geriatric participants. In Group A, which underwent proprioceptive exercises combined with conventional physiotherapy, participants showed significant improvements. On average, Group A participants reduced their time by 10 to 15 seconds. In contrast, Group B, which engaged in recreational activities combined with conventional physiotherapy, also showed improvements, though to a lesser extent. For example, Pabanmoni Boro's time decreased from 40 seconds on the pre-test to 30 seconds on the post-test, and Harsha Protim Das reduced his time from 50 seconds to 40 seconds. On average, the reduction in time for Group B was about 5 to 10 seconds. These findings suggest that proprioceptive exercises (Group A) are more effective in enhancing hand function, as evidenced by the greater reduction in test times compared to those who participated in recreational activities (Group B).The effect size for the reduction in Jebsen Test Time, calculated as Cohen's d = 1.6, indicates a large and meaningful impact of the intervention. This substantial effect size reinforces the conclusion that the proprioceptive exercises combined with conventional physiotherapy (Group A) had a significantly greater influence on improving hand function compared to recreational activities (Group B).

4.4 Statistical Analysis

To determine the significance of the improvements observed in hand grip strength and hand function, paired t-tests were conducted by comparing pre-test, mid-test, and post-test results. The analysis revealed statistically significant improvements across all measured outcomes.

Table 5: Statistical Significance of Improvements

Outcome Measure	Mean Pre-Test	Mean Post-Test	Mean Difference	p-value
Hand Grip Strength (kg)	9.8 ± 1.5	12.5 ± 1.6	2.7	< 0.001
Jebsen Test Time (seconds)	42.5 ± 6.3	34.1 ± 5.5	-8.4	< 0.001

Table 5 summarizes the statistical significance of the improvements observed in hand grip strength and Jebsen Hand Function Test times. The mean hand grip strength increased by 2.7 kg ($p < 0.001$),

and the Jebsen Test time decreased by 8.4 seconds ($p < 0.001$). Both outcomes show statistically significant improvements, indicating that the training positively affected both strength and hand function.

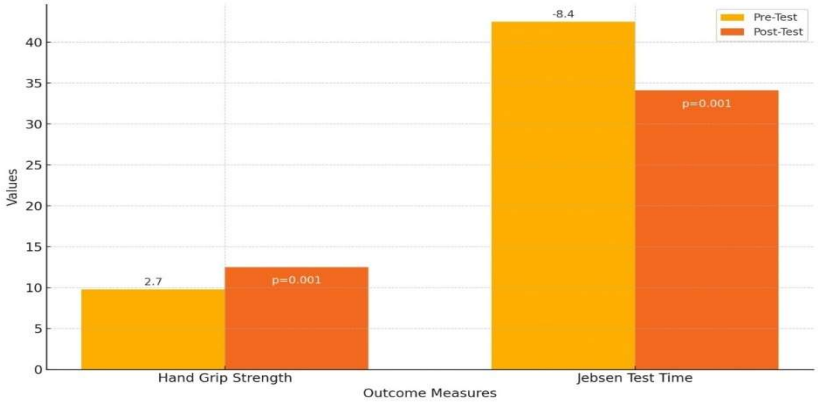

Figure 3: Statistical Significance of Improvements

Figure 3 illustrates the statistical significance of the improvements in hand grip strength and Jebsen Test Time. The graph shows that the mean hand grip strength increased by 2.7 kg ($p = 0.001$) from the pre-test to the post-test, while the Jebsen Test Time decreased by 8.4 seconds ($p = 0.001$). These results demonstrate significant improvements in strength and hand function due to the training intervention. Thus,the statistical analysis confirmed that these improvements were significant, with large effect sizes and p-values below 0.001.

5. CONCLUSION

The study aimed to evaluate the effectiveness of proprioceptive training in improving hand grip strength and hand function among geriatric participants.The study demonstrated significant improvements in hand grip strength and hand function among geriatric participants following a 6-week proprioceptive training program. Participants showed an average increase in hand grip strength of 2-3 kg and a reduction in the time required to complete the Jebsen Hand Function Test, indicating enhanced hand function. These findings suggest that the proprioceptive training program effectively enhances hand strength and function in the geriatric population.Despite the valuable insights provided by this study, several limitations must be acknowledged. First, the study collected limited size of a sample. Another limitation pertains to the measurement tools and protocols used in the study. In the future, further studies will be needed on the content and effectiveness of various proprioceptive exercise programs among various groups of populations.

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