Comparison of functional task training and resistance training to improve grip strength and hand function in elderly male and female population.

Romsha Singh
Department of Rehabilitation sciences
Jamia Hamdard University
New Delhi, India
romsha.official05@gmail.com

Ashima Chachra
Department of Rehabilitation sciences
Jamia Hamdard University
New Delhi, India
ashimaarora2708@gmail.com

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Abstract- Aging is strongly associated with impaired mobility and decreased physical functional performance. Hand undergoes many physiological and anatomical changes associated with aging, its prehension decreases. Test shows that hand function in elderly population diminishes slowly after 65 years. This reduced wrist motion and joint strength of elderly adults put them at greater risk for developing cumulative trauma disorders. According to the recommendations of the American Society of Hand Therapists (ASHT), hand grip strength (HGS) is a good predictor of general muscle strength· Since grip strength plays a key role in performing daily activities, the purpose was to compare set of functional and resistance exercises to enhance this strength in elderly population so that they can perform daily activities with ease and comfort. 32 participants were selected using random sampling from Jamia Hamdard rehabilitation centre. Handheld dynamometer and Michigan hand outcome questionnaire were used to investigate hand strength and hand function respectively post exercises. Clinically, this experiment shows that functional task specific training and resistance training both can be used to improve hand function of elderly population but while evaluating change in hand grip strength after exercises, resistance training is proved to be a better method comparatively.

Key words- Grip strength, Hand function, Aging, Handheld dynamometer, Michigan hand outcome questionnaire

Introduction- Aging is strongly associated with impaired mobility and decreased physical functional performance. As a consequence, there is a loss of independence and quality of life, and the risk of falls and fractures increases. Approximately 20% of people between 65 and 75 years of age need assistance performing activities of daily living (ADLs), and this increases to 48% in people older than 85.[1] Aging decreases the grip strength and hand coordination[2]. Hand acts as a mean of nonverbal communication, and a major sensory tactile organ. Test shows that hand function in elderly population diminishes slowly after 65 years. There is an average decline in wrist flexion (12%), wrist extension (41%), and ulnar deviation (22%), and these declines double during the following decade. This reduced wrist motion and joint strength of elderly adults put them at greater risk for developing cumulative trauma disorders. [3] Hand undergoes many physiological and anatomical changes associated with aging, it's prehension decreases. Due to loss of water content, proteoglycans and collagen type 1 fibres, tendons get stiffer. Fingernails also undergoes various changes, discolouration from white pink to yellowish grey colour, contour changes along with the thickness and roughness of nail surface. According to researchers, there is more loss of number of motor units in median nerve (thenar muscles) compared to ulnar nerve (hypothenar muscles) after age 60. [3] Nervous system changes include decrease in nerve conduction velocity, sensory activity, rate and magnitude of reflex response and arousal threshold. visual changes that can affect the hand function include acuity, accommodation, and colour differentiation, sensitivity to light, depth perception and eye hand coordination. [4]

Gender difference was also found, with elderly women experiencing more serious declines in fine manual dexterity and strength than men of a similar age.[3] Exercises is an accessible form of prevention of physical functional decline .There seems to be a paucity of

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studies on the effectiveness of resistance training in improving hand function in the elderly. The aging process is associated with muscle fibre's atrophy, decreased muscle physiological cross-sectional area and muscle power. Studies indicate that resistance training can contribute to regain significant part of muscle mass and function through muscle and neural adaptation. This nervous adaptation includes improved motor neuron excitability, down regulation of inhibitory neural pathways, and decreased presynaptic inhibition whereas muscular adaptation includes muscle hypertrophy, increased specific tension of muscle fibres and increased tendon stiffness.[2],[5] Results claim that muscle mass can be increased through training at an intensity 60%- 85% of individual maximum voluntary strength to reduce sarcopenia and retain motor function.[6] The performance of functional tasks, however is more complex and involves interplay of cognitive, perceptual and motor functions and is closely linked to the individual's dynamic environment.[7] Paul Nico and Monique suggested that functional task exercises are better than resistance exercises in improving daily function in older women and lasts longer than gain in muscle strength achieved with resistance training.[1] An article by Ahmed M. Azzam states that to improve grip strength in hemiplegic cerebral palsy children, task specific hand function training combined with traditional physiotherapy exercises is better compared to only physiotherapy exercises. [8]

Studies have co-related strength training with clinical conditions like hand Osteoarthritis, Rheumatoid arthritis, post hand fracture and stroke. They have also emphasized upon the intensity and efficacy of grip strength training on ADL activities in elderly population but scant attention has been paid on precise grip strengthening protocol to improve hand function ability in elders so that they can perform their daily task easily.

Materials and methods-

Study area and design- The study was conducted in Jamia hamdard rehabilitation centre and sector-46, Gurgaon, Haryana. Sample size of 32 were selected through random sampling where exercise intervention was given for 4 weeks. 32 individuals were divided equally in 4 groups- male resistance training, male functional training, female resistance training and female functional training. Handheld dynamometer and Michigan hand outcome questionnaire were used to investigate hand strength and hand function respectively post exercises.

Exercise program- **Group A (Functional task exercises)** - Lateral pinching of thumb, lacing a shoe, Turning keys in a lock, Hook different objects and walk for 3 minutes, carrying half litre plastic bottle from one hand to another, transfer sand bag from one hand to another, opening and closing of jars, wriggling out wet clothes, carrying plate with weight and walk for 3 minutes, moulding clay to flat disc.

Figure 1- Carrying bottle

Figure 2- Carrying plate with weight

Group B (Resistance hand exercises)- Placing Thera putty in palm and bending fingers (full grip), Squeeze ball of Thera putty between index finger and thumb (2 point pinch), Build a roll of Thera putty with one hand on table, Take the putty, stretch it out and wrap it around your hand in a donut shape while keeping your fingers together. Then spread your fingers out to stretch the putty (finger spread), Place ball between pad of thumb and pads of index and long finger. The extended fingers then squeeze through the Thera putty ball until the pads of thumb and fingers touched. (3 point pinch), Take hand gripper and squeeze it, hold it for a while and then release it, hold squeeze ball and count till 5.

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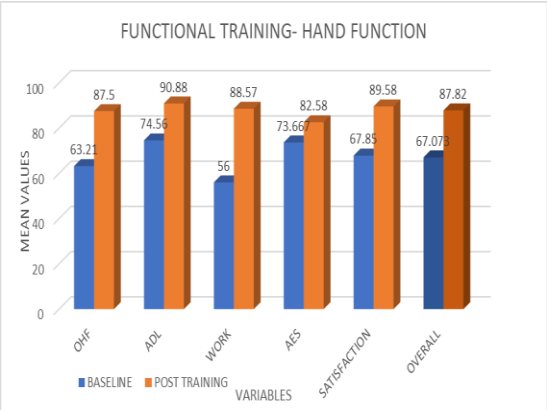
Figure 3- Thera putty finger spread

Figure 4- Thera putty squeeze

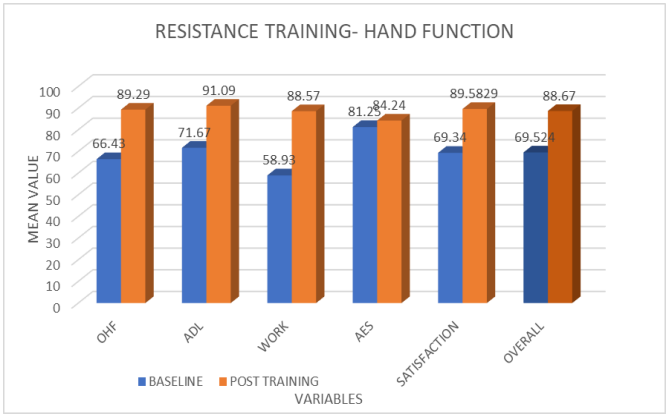
Data analysis- Data was analysed using SPSS software, version 21. Data collected was tabulated where mean and standard deviation was analysed. Paired t-test and ANOVA (2*3 split plot) was used to find effect of functional and resistance training on grip strength and hand function . The test were applied at 95% confidence interval and p values set at 0.05. The results were taken to be significant if $p<0.05$.

Results-

Both functional and resistance group shows increase in all the components of MHQ with t value greater than 1.96. Overall mean value of hand function changes from 67.07 +/- 2.9 to 87.82 +/- 3.6 in functional training group and 69.52 ±5.7 to 88+/- 4.3 in resistance group with t values greater than 1.96. Hence the difference is statistically significant. Result shows that there is significant improvement in hand function after training in all the groups.



Graph 1- Functional training effect on hand function



Graph 2- Resistance training effect on hand function

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To investigate effect of functional and resistance training on hand grip strength, a 2x3 split plot ANOVA revealed significant effect of time F (2, 26) = 44.03, p < 0.001. The main effect of group effect was found to be non-significant F (1, 26) =0.097 , p=0.758. However the interaction effect was significant F (1, 26) = 5.47, p=0.007, indicating that the resistance group showed greater improvement in grip strength following training.

Table 1- Effect of functional and resistance training on hand grip strength

	baseline		**week 2**		**Week 4**		**Time effect**		**Group effect**		**Time X group interaction**	
Grip strength	**mean**	**SD**	**mean**	**SD**	**mean**	**SD**	**F - value**	**P-value**	**F-value**	**P-value**	**F-value**	**P-value**
Functional group	19.10	7.350	20.43	7.56	21.23	7.8	44.03	<0.001*	.097	.758	5.477	.007*
Resistance group	18.64	5.556	21.60	7.28	23.01	7.29						
TOTAL	18.87	6.398	21.02	7.31	22.12	7.45						
*significant as p <0.05												

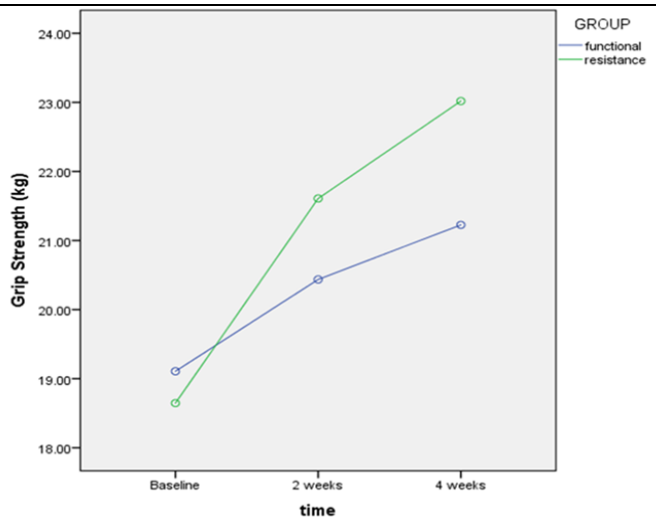

Figure 5- Effect of functional and resistance training on hand grip strength

While comparing the change in grip strength value in all 4 groups, significant change in grip strength of male resistance group was seen as T- value was more than 1.96 (2.64) and p <0.05 (0.037) when compared to male functional group. Whereas change in grip strength value is insignificant in both female functional and resistance groups.

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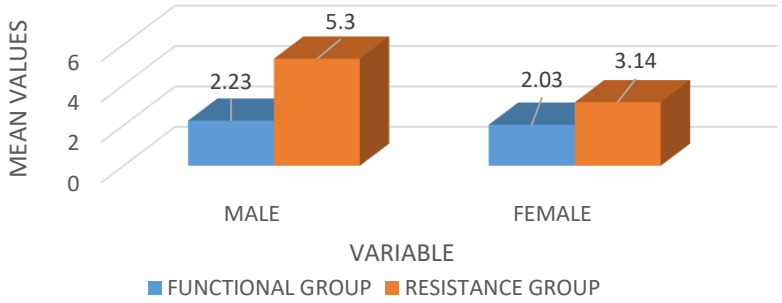

Graph 3- Change in grip strength value of all four groups

Discussion- The current study suggests that both functional task specific training and resistance training can be used to improve hand grip strength and hand function. The statistic result emphasizes that although both types of exercise is capable to bring change in mean values of hand function after 4 weeks, there is insignificant result when change in hand function parameters were compared within male subgroups and female subgroups. This indicates that both types of training bring equal change in males and females hand function.

Simultaneously, functional task training and resistance training has shown significant difference before and after exercises in hand grip strength of elderly population. Whereas when change in grip strength was compared between all 4 groups, only male resistance group has shown significant amount of change compared to male functional group but no such result was visible in female functional group and female resistance group.

The mechanism of hand function involves following pathway- information coming from periphery reaches to spinal cord through spinal nerves, from head and neck to brainstem through cranial nerves. Both the information sensitizes in thalamus and then to post central gyrus to be localized. After information reaches to cerebellum and basal ganglion to be smoothening and prevention of excessive activity, then reaches to pre- central gyrus to produce permanent changes and new motor behaviour. [8] The functional task exercise concentrates more on the day to day activities like washing utensils, wringing clothes, opening and closing door, all these deteriorates with ageing which is correlated with reduced hand grip strength. [3,7] Graph 1 and graph 2 suggests that overall mean value of hand function changes from 67.1 +/- 2.9 to 87.8 +/- 3.6 in functional group and from 69.5 +/- 5.7 to 88.6+/- 4.3 in resistance group with $p < 0.005$, therefore both can be used to improve hand function. Adam, Jeffrey and roger believed that functional task training not only improves hand function but also enhances force steadiness of hand muscles in old adults [9]. In table 1, functional task group shows improvement in grip strength mean value with time as F value= 44.3 and P value <0.005 but no significant change occurs when compared to resistance group. This indicates functional task specific training can be a useful way to increase grip strength but practically provides less benefits. Researchers say that when physiotherapy treatment is combined with functional specific task exercises of hand, it does wonders. [8]

According to result, both functional and resistance training can be used to improve grip strength. ANOVA test shows that resistance training has better improvement on grip strength following training as p= 0.007. According to researchers weight training which is the part of resistance training based upon principle of gravity (weighed bars, dumbbells or hand cuffs) to oppose the force generated by muscle through eccentric and concentric contraction.[10] The objectives of resistance training in elderly population are increase in muscle strength, reduction of sarcopenia, adaptation of tendons and bones and prevention of falls and injuries.[6] Resistance training is associated with increased synchronization in the firing of motor units which is likely to decrease the ability to steadily produce force. In older individual, resistance training improves this steadiness of force production. This ultimately result in muscular and neural adaptations of fibre's thereby increasing muscle strength and power. [5]

Research indicates significant change in grip strength in males during 4 weeks as $p<0.05$ and t value greater than 1.96. It is a well-known fact that androgens have an anabolic effect on the musculoskeletal system of males, resulting in increased muscle strength. S. bhasin investigated that when this natural occurring hormone 'testosterone' injection is combined with resistance strength training in men, it increases fat free mass, muscle size and strength. Therefore women have higher risk of physical frailty and decreased hand grip strength and manual dexterity than males. [11,12,3] On contrary to this, researchers said that excessive resistance training in elderly population might cause damage to cartilage of hand joints, leading to OA[6]. Applying same amount of resistance to every participant might produce negative effect to those who have weak muscle mass. Therefore all exercises should be manipulated accordingly on the basis of age, gender and goal of treatment.

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Relevance and conclusion-

Functional task specific exercises and resistance exercises, both can be used to improve hand function and hand grip strength in elderly population but resistance training has shown better result on hand grip strength. Also, functional training and resistance training bring equal amount of change in hand function and grip strength in females with time whereas resistance training is better than functional training to improve grip strength in male elderly population.

The functional training has no side effects, inexpensive method, readily accepted by the patients and easy to perform in any environment while resistance training shows promising result, easily approachable and less time consuming method according to this study.

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