Original Study

The Relationship between Hand Dexterity with Hand Grip Strength in Young Males

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Abstract

Background: Hand dexterity a measure of hand flexibility and coordination can be affected by many factors including hand grip strength. However, there are limited studies and data about the association between hand dexterity and grip strength in Asian population. Hence, we aim to investigate the relationship between hand dexterity and hand grip strength in healthy males aged between 18 to 25 years old in Asian population.

Methods: Fiftyhealthy adult male participants between 18-25 years were recruited by advertisement.Hand grip strength and hand dexterity test by using a handheld dynamometer and Purdue pegboard test, respectively was measured. Purdue pegboard test consisted of two main parts: 1. Inserting pins into the pegboard holes using left, right, and both hands in 30 seconds. 2. Assembly using pins, collars, and washers in one minute. Pearson correlation coefficient and regression analysis was used to study the association between hand dexterity and hand grip strength.

Results: The results showed no correlation between left, right and combined hand dexterity with hand grip strength (p value = 0.481 and r = 0.099, p value = 0.181 and r value = 0.188, and p value= 0.945 and r value= 0.009) respectively. Moreover, the results also showed no statistically significant association between number of assemblies built and grip strength (p value = 0.430 and r value=0.111).

Conclusion: Our results suggest that there is no statistically significant relationship between hand dexterity and hand grip strength in young males aged between 18 to 25 years old. Thus, it can be concluded that hand grip strength is not a factor that affects hand dexterity in young adult males of Asian population.

Keywords: Dynamometer, Perdue Pegboard, hand dexterity and hand grip strength

Introduction

Hand is a group of complex joints which is considered the most interactive and active portion of the upper extremity. It is very important and useful in body and sign language. Besides, hand helps us to grasp, grip, and perform precise motions such as writing and sewing. Furthermore, a dexterous hand allows one to use their fingers and hands to perform

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daily tasks effectively. The central feature of effective functional performance of the upper limb relies on the synchronous interrelationship between sensory and motor components, which allows humans to control fingers independently regarding timing, kinetics, and force[1].

Hand grip strength is a screening tool that could be used to measure muscular strength generated by one's upper extremity. Hand grip strength is also a predictor of general fitness because it correlates to a person's nutritional, bone mineral, and muscle strength status[2,3]. Tsuji et al. proved that grip strength was a determinant of the mineral density of radial bones in young athletes' dominant forearms[4]. Besides, Ozdurak et al. also discovered that forearm muscular strength had a minimal relationship with bone mineral density in males. Moreover, the maximum muscle strength gained through grasping exercises could be a good predictor of bone mechanical characteristics due to muscles connected to the forearm create the majority of the voluntary load on the bones [5].

Additionally, several cross-sectional studies have suggested an association between hand dexterity or grip strength and overall cognitive function [6]. Between persons with mild cognitive impairment and healthy adults, clinical trials found significant disparities in motor dysfunction. For daily tasks requiring cognitive engagement, such as writing, cooking, crafting, and gardening, hand grip strength and coordination are necessary [6]. Motor speed skills, planning, attention allocation, and visual search are required for hand movements. Therefore, executive function, which is made up of the cognitive processes of attention, planning, judgement, working memory, inhibition, and task flexibility, has a significant impact on hand motor function levels [6].

Hand grip strength can influence one's hand dexterity. Hand dexterity is less predictable and most related to age, sex, and dominance [7]. A study by Omar et al. reported that hand dexterity and grip strength may be influenced by demographic characteristics [8]. Besides, one's hand dexterity may also decline with age due to neuromuscular function decline may affect one's performance on the daily task [9]. When age increases, the muscle strength decreases thus elderly may have poor force control. A more recent study reported that hand grip strength is associated with faster upper extremity mobility [10]. However, elderly data is not suitable to represent young males due to differences in age, muscles control, and lifestyle.

Therefore, the purpose of this study was to know how hand dexterity could influence one's handgrip strength in younger age group. This normative data helped further study hand dexterity and grip strength to predict general fitness and various diseases.

Methods

Fifty healthy male volunteers were recruited by advertisement and explained in detail about the study protocol. All participants signed a written informed consent form as proof of the agreement to participate in this study. The inclusion criteria of healthy males between 18 to 25 years with a normal BMI between 18.5 to 24.9kg/m2, having the right hand as the dominant hand, and without any medical illness was used in this study. This research study only tested the dominant right hand to standardize the data in this research. Participants who had recent hand injury or surgery, congenital or acquired hand deformities (unequal or uneven finger), and hand having pathological conditions the hand and cervical problems were excluded from this study.

The demographic data, including gender, age, weight, height, and dominant hand was collected from the participants. Their body weight was calculated using a digital scale to the nearest 0.1 kg, and their height was calculated using a measuring tape to the nearest 0.1 cm. This was used to calculate the participant's BMI. The participants' reported preference for using their dominant hand for activities including eating, writing, and opening and closing doors was used to determine hand dominance.

Hand dexterity performance:

The Purdue pegboard test was used to assess participants' hand dexterity. There were four sections to the hand dexterity test. Participants used one hand

individually for each segment in segments 1 and 2 to place pins into the board. Following that, in segment 3, participants simultaneously inserted the pins with both hands. In segment 4, participants used pins, collars, and washers to build miniature assemblies while utilizing both hands simultaneously. The outcomes were then computed and recorded. The test generates four different scores based on the entire test process. These tests were repeated three times, with the average findings calculated for each subject. In order to reduce measurement mistakes, the subjects' hand dexterity was evaluated using the same Purdue Pegboard and stopwatch.

Hand grip strength:

The hand grip strength of healthy male volunteers was measured using a hand grip dynamometer. The participants were told to sit straight with their left and right elbows flexed at right angles. For testing, a portable dynamometer was held in their dominant hands with their wrists in a neutral posture. Additionally, the control handle of the dynamometer was adjusted, and the results were recorded as a kilogram. The experiment's steps were repeated three times, and the average results were calculated for each subject. To reduce measurement mistakes, each participant utilized a handgrip dynamometer that was the same.

Statistical Analysis:

Pearson correlation coefficient was used to study the association between hand dexterity performance and hand grip strength in young males. The association between the two variables was ascertained using the regression analysis. Additionally, the hand grip strength and dexterity graphs were plotted. P values less than 0.05 were considered statistically significant.

Results

Physical Characteristics, Hand Dexterity and Hand Grip Strength measurements:

Table 1 provides the subjects' physical characteristics parameters, including age, body mass index (BMI), and hand grip strength. Table 2 shows the average subjects' hand dexterity performance which includes dexterity scores for left, right, both hands, and the number of assemblies built by subjects.

Table 1: Physical characteristics of study participants:

Physical Characteristics	Average	Standard deviation
Age	20.6 years	1.37
BMI	21.68kg/m^2	1.90
Hand grip strength	33.95 kg	8.11

Table 2: Hand dexterity scoring data of study participants:

Hand dexterity	Average	Standard deviation
Left hand	14.03	1.57
Right hand	15.27	1.42
Both hand	12.33	1.34
Assemblies built by subject	38.15	5.82

Association between hand dexterity and hand grip strength:

The association between the hand grip strength and the hand dexterity test of left hand, right hand, both hands and number of assemblies were examined using regression analysis and Pearson correlation coefficient (Figure 1). The regression analysis results indicated that there was no association exists between left, right and combined hand dexterity with hand grip strength (p value = 0.481 and r = 0.099, p value = 0.181 and r value = 0.188, and p value= 0.945 and r value= 0.009) respectively. The results also showed no statistically significant association between number of assemblies built and grip strength (p value = 0.430 and r value=0.111).

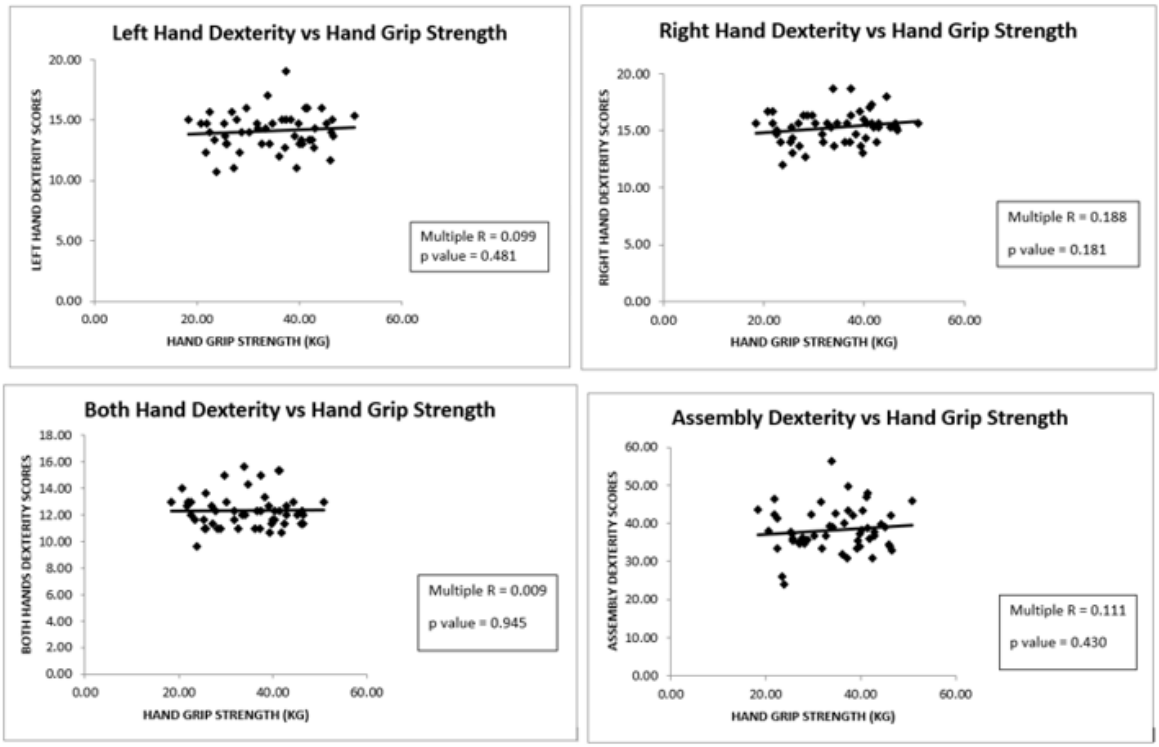

Figure 1: Correlation analysis of left, right both hand and assembly hand dexterity scores vs hand grip strength

Discussion

This present study findings expand on previous research on grip strength and dexterity. In our study, we showed that there are no associations between hand grip strength and hand dexterity in young healthy adult males. Hawardet al. tested four groups of 18 subjects, two groups of volunteers were 18 to 25 years old, while two elder groupswere 45 to 55 years old [11]. The results showed that there was no discernible relationship between hand grip strength and dexterity function. It suggested that manual dexterity is not associated with musculoskeletal function. Therefore, a decline in hand dexterity might not indicate a decline in hand grip force.

However, some studies suggested a relationship between hand dexterity and hand grip strength in other groups of people, such as the elderly. Incelet al. tested 24 senior volunteer patients between 64- and 79 years old [12]. The study revealed a significant correlation between the Dreiser and Duruözindices – a functional disability score and the grip and pinch strengths in this geriatric group. These two indices had the strongest correlations with Lawton Instrumental Activities of Daily Living (IADL), which the study chose to measure activity limitation. Furthermore, the study also presented that the function of hand-muscle and functional dependency in older people are correlated [12]. Other than that, Shiffman et al. also reported that age-related declines in hand strength are positively correlated with reduced functional performance in activities requiring dexterity, strength, or both[13]. Indeed, another study also confirmed the relationship between dexterity and fine hand use (DFHU) task performance and grip strength in children aged between 3 to 13 yearsold[14]. This study suggests that potentially all these variables may reflect a construct called "children's upper limb motor performance". However, the relatedness of the motor performance measures was significantly diminished by partial correlations that took age into account [14].

In contrast, Martin et al. reported that grip strength accounted for more variation in aiming and tapping hand dexterity tasks than age [15]. The study shows that the hand dexterity tasks is declined significantly when the hand grip strength decreases. The research suggested that the adult with greater grip strength will have greater hand movements compared to adult with poor grip strength [15]. This

study also shows that hand strength appears to be closely related to dexterous activities that depend on the quick and exact coordinated movement control of the wrist, hand, shoulders and elbow such as that tapping and aiming [15]. Although this is the first time this argument has been raised, it is well recognized that well-controlled muscular forces, sensory information, and body plan are necessary for successful muscle coordination during movement execution. Muscle force changes during a movement affect the ability to execute the planned movement accurately, resulting in compensatory movements [15]. The thumb and index finger must pinch the stylus object while pointing and tapping with a minimum force more significant than the friction force necessary to prevent the object from slipping when raising it. The execution of the quick tapping and targeting actions then necessitates substantial muscle activations with quick movement accelerations in response to the job. The stylus must simultaneously coordinate force with movement accelerations and the target's impact while pinched between the thumb and index finger. Therefore, diminished strength will increase force capability variability, increasing movement trajectory variability and ultimate position accuracy [15]. Repeated executions of these effects will compound their effects. In repeated performances of a task such as the tapping task, these effects will be amplified because variations in muscle force during a voluntary contraction will increase the variance of movement kinematics from trial to trial [15].

Furthermore, the relationship between total number of assemblies built by subjects and hand grip strength was studied in our study. Our findings suggested that there is no relationship between number of assemblies built with hand grip strength. This suggests, unlike finger tapping and peg-placing activities, grip strength does not necessitate autonomous or precise finger control. For instance, in their seminal paper, Lawrence and Kuypers discovered that although monkeys lost their ability to move their fingers separately following a pyramidotomy, they were still able to strongly flex them together in a power grip [16]. It was also found that, whereas grip strength asymmetry was substantially connected with finger tapping asymmetry in right-handers, it was unrelated to finger tapping asymmetry in left-handers [16].

Conclusion

In conclusion, the present research study shows that there is no relationship between number of assemblies built, left, right, both hand dexterity scores and hand grip strength in young males aged between 18 to 25 years old.

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Conflict of Interest: There is no conflict of interest declared in this study.

Ethical Clearance: This study was cleared by the Joint Research and Ethics Committee of International Medical University, Kuala Lumpur, Malaysia. Approval date : 19/01/2023 (258th IMUJC Meeting) Reference number : BP I-01-2023(04). Written informed consent was obtained

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