Correlation between Age, height and weightwith Hand Grip Strength.

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Abstract: Back ground: The Hand Grip Strength measurement is clinically used to determine the functional integrity of the hand and the effectiveness of hand rehabilitation programs.
Purpose: This study was conducted to find out the relationship between Age, Anthropometric measurements as height and weight and Hand Grip Strength in both right and left hands.
Methods: Hand grip strength was measured using Jamar hand –held dynamometer, in 1029 individual, of which 505 were female and 524 were male, with age range from 20 to 85 years old, mean age (42.44 ± 15.727). They were randomly selected from urban, suburban and rural areas.
Results: There was inverse significant correlation between age, height and weight with right and left hand grip strength in female, male and all participants as a whole, as ($p < 0.05$). Furthermore, there was significant direct correlation between height and weight with right and left hand grip strength in female, male and all participants as a whole as ($p < 0.05$) except for the correlation between female right hand grip strength and weight which was not significant with ($P > 0.05$).
Conclusion: Age was inversely correlated with Grip strength for both right and left hands. The height and weight showed significant direct correlation with Grip strength for both right and left hands, except that the weight didn't correlate with female right hand grip strength.
Key words: Hand grip strength, Age, Height, Weight, Dynamometer.

1. Introduction

The hand functions as the primary effector organ of the upper extremity for support, manipulation and prehension. As a support the hand acts in a non specific manner to stabilize objects, often freeing the other hand for a more specific task. The hand may also be used as a simple platform to transfer or accept forces. The power grip is used when stability and large forces are needed without the need of precision. The shape of the held object might be spherical or cylindrical. Using a hammer activity requires strong forces from the finger flexors, especially from 4th and 5th digits. Intrinsic muscles of the fingers specially the interosseii, the thumb adductors and flexor musculature, wrist extensors are needed to stabilize the partially extended wrist[1].

Being unique the human hand is free of habitual locomotion duty and devoted entirely to function of manipulation[2,3].In the activities of daily living and sports activities including gripping and pulling, the main demand is on the hand muscles, so hand grip strength is of great importance and it's correlation with all over body strength[4].

Hand grip strength (HGS) evaluates the functional integrity of the hand being one of the most important parts of the musculoskeletal system. Hand grip strength measurement is clinically used to decide whether a treatment program is effective or not[5], to provide normative data[6,] and to give motivation and feedback for the patient with hand dysfunction to complete their rehabilitation program[7].

Examination of hand strength is of great importance for identifying impairments, establishing goals, and determining the effectiveness of interventions for patients with hand or upper extremity injuries ordisabilities[8].

Jamar hand -held dynamometer is a valid, reliable device used to measure hand grip strength, it is a standardized calibrated and gives accurate readings even when used by different assessors[9,3].

Hand plays an important role in most of the daily muscular activities. Many factors could affect HGS and few studies have shown correlation of age, height, weight and hand grip strength[10].

Hand strength depends on a patient's age, sex, and hand dominance[8].Age and gender are influencing factors for all types of grip strengths, meanwhile there is distinct difference between right and lefthands[11].

Almost all of the studies in literature that correlated age, height and weight to hand grip strength tested the dominant hand and either compared it to the nondominant or not. In our study we tested both hands in terms of being right and left despite the dominance.

Some studies was conducted to find the age correlation with hand grip strength and found the correlation significant[12].The study done by[10] showed significant positive correlation of dominant hand grip strength with age, height and weight. [3]found a strong positive correlation between age, height and weight with hand grip strength. Furthermore, [13]found an excellent significant correlation between age, weight height and body mass index, with hand grip strength. On the other hand, another study reported that hand grip strength decreases with age as studies by [14,15].

This conflict of whether age have a positive or negative correlation with hand grip strength, makes it important for us to perform our correlation study keeping in consideration that we perform on a wide age group 20-85 years .

The objective of this study was to find the correlation between hand grip strength and the anthropometric data as height and weight along with age in right and left hands.

2. Subjects, Materials and methods

This research is designed to measure maximum grip strength of right and left hands in a convenient sample of 1029 healthy individual of age range from 20 to 85 years. Measurements were completed in one session.

To ensure a representative sample according to age and socioeconomic background, the sample was randomly selected from urban, suburban and rural areas from a wide variety of settings (hospitals, senior sports groups, and senior residences, universities, shopping malls, workplaces, community centers for the elderly to realize a random approach. The characteristics of the participants are shown in Table 1. The study was approved by the ethics committee of the Faculty of Physical Therapy, Cairo University. All patients signed the informed consent form, agreeing to participation and publication of the results of the study.

Inclusion criteria were as follows: age of participants range from 20-85 years old, both genders and all participants perform all Activities of daily living (ADL) easily.

The following participants were excluded from the study:

Those who have restriction of movement in the upper limbs, inflammatory joint disease, Neurological disorder or injury to the upper extremity, neuralgias, my algias and orthopaedic conditions, subjects with surgery in the upper extremity, any diseases, injuries, or conditions that affected upper limb function during the previous 6 months, on others and Athletes.

Instrumentation:

Grip strength testing was performed using Jamar dynamometer(Sammons Preston Rolyan 4 Sammons Court, Bolingbrook, IL 60440 1-800-3235547)

Jamar dynamometer is an isometric, hydraulic, valid and reliable hand dynamometer and has been reported to be a reliable and valid instrument for measuring hand grip strength in healthy individuals [16].Jamar dynamometers has been found to give the most accurate and acceptable measures of grip strength [17,18].

The dynamometer handle was set in the second position for all participants to ensure maximum standardization[19]. The Jamar dynamometer was calibrated before the first measurement, the average of three measurements per person was recorded[6].

Measurement procedure:

Measurements were performedforright and left hands for all participants.The standard grip-testing position recommended bythe American Society of Hand Therapists (ASHT) was used as done by[6].

The subjects seated upright against the back of a chair (without armrests) with feet flat on the floor shoulder adducted and neutrally rotated, elbow flexed 90 degrees, forearm in neutral position wrist slightly extended (0–15), between 0 and 15 ulnar deviation[6].The participants were asked to use all the inside of their hand and all their fingers, including the thumb[20].

Standard instructions were given at a constant volume, since verbal instructions [21]and the volume of a verbal command [22]can influence performance on evaluation tests. The mean of three trials was taken; both hands were tested alternatively allowing for about 1 minute rest[6].

The subject was asked to hold the dynamometer in a comfortable position and when they are ready they would squeeze the handle ashard as they are able. After one maximum squeeze they were asked to relaxtheir hand andthe examiner recorded the measurement[23].

Statistical analysis:

Data was statistically described in terms of mean, standard deviation and range of frequencies (number of cases) and percentages when appropriate. Correlation between age, weight and height with hand GS was done using Spearman rank correlation. P values less than 0.05 was considered statistically significant. Statistical calculations was done using computer SPSS (Statistical Package for Social Sciences; SPSs Inc., Chicago, IL, USA) release 15 for Microsoft Windows (2006).

Results:

General characteristics of the subjects:

The hand grip strength was measured for 1029 individual with mean age 42.44±15.727, mean right hand grip strength 31.21±11.236 and mean left hand grip strength 29.65±11.153. Their mean height was 167.58±9.951 and their mean weight was 78.27± 13.988.

Out of these 1029 subjects, 505 were female and 524 were male. The female mean age was 42.34±16.089, and the mean right HGS and left HGS were 22.66±5.829 and 21.19±5.701 respectively .Their mean height was 161.33± 7.735 and mean weight was 73.57±12.468. Whereas the male mean age were 42.54±15.386 and mean right HGS and left HGS were 39.45±8.768 and 37.81±8.789 respectively. Their mean height was 173.60±7.937 and their mean weight was 82.80±13.887, Table 1.

Table (1): General characteristics of subjects.

Gender	Female	Male	Total
Number of subjects	505	524	1029
Age	42.34±16.089	42.54±15.386	42.44±15.727
Height	161.33±7.735	173.60±7.937	167.58±9.951
Weight	73.57±12.468	82.80±13.887	78.27±13.988
Right HGS	22.66±5.829	39.45±8.768	31.21±11.236
Left HGS	21.19±5.701	37.81±8.789	29.65±11.153

Correlations between age, weight and height with Hand grip strength

Regarding the correlations between age and Hand grip strength of the whole sample of 1029 subject, there is a significant inverse correlation between age and right hand grip strength as the correlation coefficient is (-0.277) and the p value is 0.0001. There is also a significant inverse correlation between age and left hand grip strength as the correlation coefficient is (-0.256) and the p value is 0.0001, as shown in table 2.

Thereisalso a significant inverse correlation between age and right and left HGS in female (n=505), as the correlation coefficient was (-0.408) and (-0.488) respectively and the p value is 0.0001 for both right and left HGS as shown in table 2.

A significant inverse correlation between age and right and left HGS in male (n=524), as the correlation coefficient is (-0.488) and (-0.459) respectively and the p value was 0.0001 for both right and left HGS as shown in table 2.

Table (2): correlation between Age with Right and Left HGS .

	Female N=505	Male N=524	Total
Rigth HGS	R= -0.408 P=0.0001	R= -0.382 P=0.0001	R= -0.277 P=0.0001
Left HGS	R= -0.488 P=0.0001	R= 0.459 P=0.0001	R= -0.256 P= 0.0001

* (R): Correlation coefficient,(P): P value.

Regarding the correlations between height and weight with Hand grip strength, a significant direct correlation was also found between both the height and weight with the right and left hand grip strength as the correlation coefficient for height with right HGS is 0.651 and that of the left HGS is 0.642 and the p-value is 0.0001.The correlation coefficient of weight with right HGS is 0.301 and that of the left HGS is 0.303 and the p-value is 0.0001 for both as shown in table 3 and 4.

Likewise in the female subjects, there is significant correlation between height with right and left hand grip strength .The correlation coefficient of the height with right and left HGS are 0.271 and 0.256 respectively and the p-value is 0.0001 for both, which means that the more the height the more the right and left HGS.

Whereas the correlation coefficient of the weight and left HGS is 0.097 and the p-value is 0.029, but this is not applicable for the right HGS as there is no significant correlation of weight with right HGSas the correlation coefficient was0.076 and the p-value is 0.087.

For male subjects, there is significant correlation between both the height and weight with the right and left HGSas the correlation coefficient for height with right and left HGS are 0.278 and 0.265 respectively and the p-value is 0.0001.In addition, the correlation coefficient of the weight with the right and left HGS are 0.139 and 0.125 respectively, and the p-value are 0.001 and 0.004 respectively.

Table (3): correlation between height with Right and Left HGS.

	Female N=505	Male N=524	Total
Rigth HGS	R=0.271 P=0.0001	R=0.279 P=0.0001	R=0.651 P=0.0001
Left HGS	R=0.256 P=0.0001	R=0.265 P=0.0001	R=0.642 P=0.0001

* (R): Correlation coefficient , (P): P value.

Table (4): correlation between weight with Right and Left HGS.

	Female N=505	Male N=524	Total
Rigth HGS	R=0.076 P=0.087	R=0.139 P=0.001	R=0.301 P=0.0001
Left HGS	R=0.097 P=0.029	R=0.125 P=0.004	R=0.303 P=0.0001

* (R): Correlation coefficient , (P): P value.

Discussion:

Hand grip strength is a physiological variable that is affected by a number of factors including age, gender and body size[3,13].

Assessment of HGS plays a cardinal role in evaluating hand power and it's relationship with age and with anthropometric measurements as height and weight are of great importance, so we conducted this study to correlate age, height and weight with hand grip strength and we found age to be inversely significantly correlated with hand grip strength, which might be attributed to several factors as aging causes diminished sensation, muscle fibers changes in type and contour and degeneration in central nervous system, diminished proprioception or decreased muscle power and recruitment abilities.

Our results also show a significant positive correlation between the height and weight and Grip strength for both right and left hands in both female and male, except that the weight didn't correlate significantly with female right hand grip strength. This agrees well with most of the results found in literature as the more the height of the subject the more his ability to grip and the more his body weight, the more muscles and fat and consequently the ability to perform strong hand gripping.

The female right hand grip strength didn't correlate with weight and this might be due to the increased demand of the daily living needs which causes fatigue, along with decreased general body strength due to lack of exercising, which shows a realistic image of the population nowadays.

[11] stated that muscle force is largely determined by the body size rather than age, [10]confirmed that height and lean body mass were closely correlated with grip and muscle strength.

The more the height of the body the longer the upper extremities and the greater the lever arm which can generate more efficient force for gripping[3,10,13,24].

The less the weight the less the body fat though less ability to perform efficient gripping[10,25], so we could conclude that on contrary the more the body weight the greater it's ability to grip efficiently.

Normal aging process that causes decline in the hand grip strength was also reported by several previous studies as with [26,27,28,29] who found a significant correlation between age and hand grip strength which supports our results.

Our findings are similar to[27] who found a significant relationship between aging and decrease of hand grip strength as the decline started gradually from the 3rd decade which he attributes to age related changes or sedentary life or both. It also agrees with[20] who demonstrated that HGS increase with age and curves down at

the age of 40.

Moreover [5],[30]agrees with us as they reported increased grip strength with age reading its maximum at 30-49 years then gradually decrease with age after that.

Furthermore [19]confirmed our results as they found inverse statistically significant correlation between age and hand grip strength and they stated that the most progressive decrease was after the age of 65.

[6]also found that strength values decrease with age, due to limited precission of strength. And [31]noted that there is a curvilinear relationship between age and hand grip strength.

In addition [18]also reported a curvilinear relationship between HGS and age, they found HGS to be significantly higher in male than in female.

In a comparative study of HGS between Asian and European population [32] mentioned that the the HGS decreases with age in both continents, but he couldn't compare results as the tools of measurement was different.

Concerning the correlation of height and weight with hand grip strength our results were supported by several previous studies in the literature, results by [5] confirms ours as they reported a significant correlation between grip strength and body weight in male, and between body height and grip strength in both sexes.

Furthermore [6],[27,29]agreed with our findings concerning the significant correlations height and weight have with Hand grip strength. In addition to [33] who found strong correlations with height and weight with hand grip strength.

Mean while [16]disagreed with us as they found no significant correlation between strength and body weight in either sexes, they agreed with us on finding body height correlating significantly for both sexes.

Nevertheless [23]didn't support our findings as they found no significant difference effect of age in both female and male, this might be attributed to the age range they included in their study as they worked on 2 groups for each gender aged 18-25 and 45-55, which could be the reason why their results are different from our's.

Furthermore the results of [16]disagrees with our results as they found no statistically significant age-related changes in strength for either sex for either right or left hands. This might be due to the considerably small sample they worked on (101 subject).

In addition [3]disagrees with our results as they found strong positive correlation with age which might be due to the difference of age range from ours as they worked on adolescents only so it is considered the same age strata.

Our results were not supported by[31] who didn't find Height or weight to be correlate to Hand grip strength, because they used a 5[th]percentile normative cut-off score for Grip strength data, which may explain why it is different from our outcomes, as we calculated a correlation between the obtained raw grip strength scores with height and weight. [13,10] found an excellent correlation between age, height and weight compared to grip strength, still the week point is that they performed their study on younger subjects in the same age strata.

Some studies couldn't be compared to ours as there is difference in equipment, testing procedures and inconsistent grouping of subjects

The decline in hand grip strength with age might be due to reduction in muscle mass[15,36]. Or properties of muscle activation and recruitment[15] or due to slower rate of muscle contraction[15, 34],or neural conduction velocity [15,35]or increase of antagonist co-activation necessary to stabilize joint during movement, which also causes restriction of the joint movement [15,36,37].

So, Physical exercises, flexibility, balance and coordination training, aerobic and endurance exercises should be done on regular basis to decrease the effect of muscle strength deterioration with aging. One possible limitation of the current study is the small number of old age cases. Further studies are required to find out the

age of the break point where the decrease starts to occur. Further investigations are also needed to find out the physiological changes of the muscle and the sensory input. Further studies should also consider life styles and physical activities of the subjects.

Conclusion:

Age was inversely correlated with Grip strength for both right and left hands in both female and male. The height and weight showed significant correlation with Grip strength for both right and left hands in both female and male, except that the weight didn't correlate with female right hand grip strength.

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