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ORIGINAL ARTICLE

Association of Hand Grip Strength with BMI in Cardiovascular Disease Patients

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ABSTRACT

Background: The strength of one's grip is a good determining factor of their overall muscularity. Grip strength can be utilized in a variety of circumstances to assess and monitor a variety of health-related conditions.
Objective: To evaluate the association of hand grip strength with BMI in cardiovascular disease patients.
Methodology: An analytical cross sectional study was done on a population basis. A total of 256 patients of cardiovascular diseases were included in this study. Data were collected through purposive sampling technique. A proforma used to get demographic data including name, age, height, weight and occupation. Their BMI was also calculated. Hand grip strength was measured through handheld dynamometer of both hands. Three trials were performed by the patients from both hands.
Results: Out of 256 total participants, 133 (52%) were males and 123 (48%) were females. Their mean age was 51.12 (SD = 12.513) and mean BMI was 26.533 (SD = 5.1012). Hand grip strength (HGS) and body mass index (BMI) had a negative and statistically significant association, for dominant hand (pearson's r = -0.309, p = 0) and for non-dominant hand (pearson's r = -0.308, p = 0). Mean hand grip strength of dominant hand was 24.677 (SD = 9.0567) and of non-dminant hand was 21.861 (SD = 8.8035). Age and duration of diseases also had a negative and statistically significant association with the hand grip strength of both hands of the patients with p value 0.
Conclusion: It was concluded that the BMI had a great impact on HGS. Presence of CVD and the duration of this disease also affect HGS. With increasing age and obesity hand grip strength decreases.
Keywords: Body mass index, Hand grip strength, Cardiovascular diseases.

INTRODUCTION

Skeletal muscle is crucial for maintaining homeostasis in all organ systems. Skeletal muscle is malleable and can change in response to load, physical activity, injury, illness, and ageing.(1) According to the International Classification of Functioning, Disability, and Health (ICFFDH), muscle strength is described as the maximum voluntary resultant output that muscles can exert on the environment while being tested under a particular set of circumstances.(2) Muscle role is critical not only for physical performance but also for long-term fitness.(3)

Skeletal muscle strength declines with age and is not only functionally salient factor, but also a determining factor of negative consequences like morbidity, dysfunction, poor quality of life, and death.(4) Muscle strength has been researched in several nations in connection to individual characteristics (gender, age, dextrality), as well as further elements that, like strength, are quick to respond to growth and development, such as weight, height, and BMI. Body composition, developmental stage, and ecological or lifestyle elements such as physical activity are all factors that contribute to overall variability.(5)

Hand grip strength is an excellent indicator of overall health, muscular endurance, dexterity, and strength.(6) Grip strength is a measure of the power of hand muscles that has been linked to physical activity.(7) It is important for the human body when executing prehensile and precise hand functions, and it is the most important marker for muscular power assessment.(8) Hand grip strength (HGS) is a common way to evaluate muscular power. Muscle strength is linked to obesity, age-related body adiposity, hypertension risk in pre-hypertensive patients, metabolic syndrome incidence, coronary heart disease, and cerebrovascular disorders.(9)

The grip strength (GS) test measures muscle strength and can be utilized to predict the probability of cardiovascular disease (CVD) incidence, CVD mortality, and all-cause mortality.(3) There are numerous advantages of utilizing HGS to assess muscle performance. HGS, for example, may be measured rapidly and simply in field-based testing compared to techniques like dual energy x-ray absorptiometry and bioelectrical impedance.(5)

Hand grip strength is influenced by a variety of parameters including age, gender, and body size.(10) Gender and age are the two main factors that influence hand grip strength, while gender accounting for the majority of the total variation.(11) Men have a better grip strength on average than women.(7) It is also influenced by age, resulting in the rise in grip strength with age that peaks between 30 to 40 years of age, and then declines.(8)

Body mass index (BMI) is a easy and acceptable weight-category screening measure that is closely linked to health status.(12) Some researches have found a negative relationship between BMI and HGS.(10) A greater BMI is linked to a lower level of performance, which in turn leads to a reduction in muscle strength. Obese women had lower muscle strength in both the upper and lower limbs than lean women, which could be demonstrated by their lower level of activity.(12) However, few studies have taken into account individual differences in BMI in relation to HGS. Moreover, according to a meta-analysis, BMI and HGS are notably related, and this relationship should be explored further.(13) The findings on body mass index are mixed: some writers discovered a favourable relationship between static grip strength and BMI, taking it as a determinant for grip strength, while others found no remarkable relationship, concluding that BMI had no bearing on handgrip strength.(8)

HGS is a simple, non-invasive test that is thought to be a reliable indicator of total skeletal muscle mass and thus was suggested as a criterion in the definition of cancer cachexia. According to a prior study HGS can be used to predict malnutrition in cancer patients. Additionally, a number of studies demonstrated that lesser HGS was negatively associated to cancer patient survival outcomes, but this relationship varied between male and female patients.(14) There has also been evidence of a link between low HGS and depression, insomnia, diabetes, hypertension, cardiovascular disease, multimorbidity, and death.(15)

Handgrip strength (HGS), an evaluation of body muscular strength and overall health state, is negatively and independently related with the probability of future CVD, other chronic diseases, and mortality outcomes, according to a large body of evidence in the literature.(16) Several large-scale epidemiological researches have found a connection between handgrip strength and the risk of cardiovascular disease (CVD), such as hypertension, coronary heart disease, and diabetes, as well as cardiovascular mortality. However, not all studies have linked handgrip strength to CVD (17) such as one study showed no link between HGS and CVD.(18)

Handgrip strength (HGS) can be simply measured with a handheld dynamometer to evaluate overall muscular strength. A maximal isometric grip force task requires subjects to squeeze a handgrip dynamometer as hard as possible for a brief period of

time (i.e., seconds), after which they must relax the contracting muscles. Because of their low expense and simplicity of evaluation, measures of HGS are used in clinical and epidemiological contexts to evaluate strength capacity. Larger population-based researches contain HGS measurements in their protocols. As a result, HGS data has been used in the United States and around the world to make a variety of health-related inferences, create HGS percentiles, and generate weakness cut-points.(19)

As it is mentioned above that the findings on body mass index are mixed so it becomes a point to ponder on. The main purpose of this study is to assess the association between hand grip strength and BMI of patients having different types of CVD. Thus the relation of included CVD and their duration, under the effect of BMI, with hand grip measurement will also be observed. Through this study there would be a clear picture of muscle strength, whether it is good or poor, in accordance with different BMI ranges and thus it would be beneficial in preparing effective interventional protocol for healthy weight status, fitness and good handgrip strength in apparently healthy people as well as in the patients having cardiovascular diseases in their cardiac rehabilitation program because poor hand grip strength is mentioned as a red flag of many fatal diseases and mortality.

MATERIAL AND METHODS

Selection and Description of Participants: This was an analytical cross sectional study. A total of 256 patients of cardiovascular diseases from Wazirabad Institute of Cardiology and DHQ hospital of Gujranwala were included in this study through purposive sampling technique. Inclusion criteria comprises of the patients with diagnosed cardiovascular diseases (Angina, myocardial infarction, rheumatic heart disease, heart failure, cardiomyopathy, abnormal heart rhythms, valvular heart disease, peripheral artery disease, carditis and hypertension) and of age 20 and above. Exclusion criteria comprises of the patients with diagnosed paralysis or hemipariesis or stroke, peripheral neuropathy, cervical radiculopathy for last 6 months, severe mental illness such as dementia or parkinsonism, diabetes, with any hand injury and surgery in last 3 months and the patients involved in any strengthening workout for last 6 months

Technical information: BMI of the patients was calculated by measuring their height and weight. A measuring tape was used to measure their height by asking the patient to stand erect without shoes and a weight machine was used to measure their weight by asking the patients to stand bare footed on it.

To measure the hand grip strength, a handheld dynamometer (Camry Model: EH101) was used and was compared with their BMI. Patients were asked to squeeze a handgrip dynamometer as hard as possible for a brief period of time (i.e., seconds), after which they must relax the contracting muscles.(19) The participants were seated in a chair during the HGS evaluation. They were then instructed to hold the dynamometer's test arm with the elbow flexed 90 degrees, the forearm in a neutral position and the hand parallel to the forearm. The dynamometer was then squeezed three times by the participants as hard as they could. This was done for both dominant and non-dominant hands, first with the dominant hand, then with the non-dominant hand, with a two-minute break in between. The weights were measured in kg, and the average over the three trials served as the HGS measurement. With a minute's rest in between, the three trials were conducted using each of the hands.(20)

Statistics: Data were analyzed in SPSS (version 23.00). Categorical variables are displayed in frequency and percentages whereas numerical variables are presented in mean and standard deviation. For inferential analysis, appropriate statistical tests i.e pearson's correlation coefficient, pearson chi-square and spearman correlation are applied. All data will be analyzed at 95% confidence interval and p-value ≤ 0.05 will be considered as significant value.

RESULTS

The results have been obtained after analyzing the data to evaluate the association of hand grip strength with BMI in cardiovascular disease patients by using purposive sampling technique. Total 256 cardiovascular disease patients were recruited for this study out of which 133 (52%) were males and 123 (48%) were females. Frequencies of variables were mentioned in table 1. Mean age of all the participants was 51.12 (SD=12.513) and mean BMI was 26.533 (SD=5.1012). Mean BMI in females 28.774 (SD=5.0744) was high than the males 24.461 (SD=4.1790). The mean HGS of dominant hand was 31.826 (SD=6.4585) and non-dominant hand was 28.621 (SD=6.5738) in males while in females, mean HGS of dominant and non-dominant hand was 16.947 (SD=3.2172) and 14.550 (SD=3.3959) respectively (Table 2). Mean HGS of dominant and non-dominant hand in males is greater than that of females. In all the categories of BMI, overweight category patients have strong HGS as compared to any other category and underweight category patients had the lowest HGS values. BMI had a negative and statistically significant correlation with the HGS of dominant (Pearson's R = -0.309, p=0) and non-dominant (Pearson's R = -0.308, p=0). Age and duration of duration had also negative and statistically significant association with HGS of dominant and non-dominant hand with p value 0 (Table 3). Occupation and weight status both had a significant association with the grip status with p value 0. Gender had a significant association with grip status of only non-dominant hand (p=0) and age duration had a statistically significant association with grip status of only dominant hand with p value 0.001 (Table 4).

Table 1: Frequencies of variables

Variables	Categories	n	%
Gender of patients	Male	133	52%
	Female	123	48%
Marital status of patients	Single	20	7.8%
	Married	236	92.2%
Age group of patients (Years)	20-29	10	3.9%
	30-39	34	13.3%
	40-49	66	25.8%
	50-59	83	32.4%
	60-69	39	15.2%
	70-79	21	8.2%
	80-89	3	1.2%
Weight status of patients	Underweight	20	7.8%
	Normal range	85	33.2%
	Overweight	90	35.2%
	Obese class 1	46	18%
	Obese class 2	14	5.5%
	Obese class 3	1	0.4%
Occupation of patients	Shopkeeper	34	13.3%
	Farmer	12	4.7%
	Salesman	6	2.3%
	Daily wager	10	3.9%
	Mechanic	7	2.7%
	Teacher	7	2.7%
	Desk job	6	2.3%
	Peon	5	2%
	Policeman	4	1.6%
	Retired soldier	12	4.7%
	Tailor	9	3.5%
	Driver	7	2.7%
	Housewife	110	43%
	Others	21	8.2%
	Barber	6	2.3%
Type of CVD	Angina	35	13.7%
	Myocardial infarction	80	31.3%
	Rheumatic heart disease	10	3.9%
	Heart failure	5	2%

	Cardiomyopathy	26	10.2%
	Abnormal heart rhythms	4	1.6%
	Valvular heart disease	42	16.4%
	Carditis	13	5.1%
	Peripheral artery disease	3	1.2%
	Hypertension	38	14.8%
Duration of disease (Years)	< 1	52	20.3%
	1-2	97	37.9%
	3-4	58	22.7%
	5-6	40	15.6%
	7-8	8	3.1%
	9-10	1	0.4%
Grip status of dominant hand of patients	Normal	115	44.9%
	Weak	141	55.1%
Grip status of non-dominant hand of patients	Normal	66	25.8%
	Weak	190	74.2%
Total		256	100%

Table 2: Mean and standard deviation of variables

	Mean	Std. Deviation (SD)
Age of patients (Years)	51.12	12.513
Height of patients (Meters)	1.64478	0.087036
Weight of patients (Kg)	71.67	13.75
BMI of all the patients (Kg/m^2)	26.533	5.1012
BMI of males (Kg/m^2)	24.461	4.1790
BMI of females (Kg/m^2)	28.774	5.0744
HGS of dominant hand of patients (Kg)	24.677	9.0567
HGS of non dominant hand of patients (Kg)	21.861	8.8035
HGS of dominant hand of males	31.826	6.4585
HGS of non dominant hand of males	28.621	6.5738
HGS of dominant hand of females	16.947	3.2172
HGS of non dominant hand of females	14.550	3.3959

Table 3: Association of hand grip strength with variables

	Pearson's R	P value
Age vs HGS of dominant hand	-0.261	0.000
Age vs HGS of non-dominant hand	-0.231	0.000
Duration of disease vs HGS of dominant hand	-0.268	0.000
Duration of disease vs HGS of non-dominant hand	-0.276	0.000
BMI vs HGS of dominant hand	-0.309	0.000
BMI vs HGS of non-dominant hand	-0.308	0.000

Table 4: Association between grip status and variables

	Pearson Chi-Square	P value	Spearman Correlation
Gender vs grip status of dominant hand	1.746	0.186	0.083
Gender vs grip status of non-dominant hand	15.374	0	0.245
Age group vs grip status of dominant hand	21.711	0.001	-0.034
Age group vs grip status of non-dominant hand	12.331	0.055	-0.119
Occupation vs grip status of dominant hand	39.337	0	-0.019
Occupation vs grip status of non-dominant hand	57.167	0	0.095
Marital status vs grip status of dominant hand	5.446	0.020	-0.146
Marital status vs grip status of non-dominant hand	1.318	0.251	-0.072
Type of CVD vs grip status of dominant hand	26.789	0.002	-0.024
Type of CVD vs grip status of non-dominant hand	13.107	0.158	-0.003
Weight status vs grip status of dominant hand	70.244	0	0.013
Weight status vs grip status of non-dominant hand	57.570	0	-0.013

DISCUSSION

Muscle strength has been researched in several nations in connection to individual characteristics (gender, age, dextrality), as well as further elements that, like strength, are quick to respond to growth and development, such as weight, height, and BMI.(5) Grip strength is a measure of the power of hand muscles that has been linked to physical activity.(7) Muscle strength is linked to obesity, age-related body adiposity, hypertension risk in pre-hypertensive patients, metabolic syndrome incidence, coronary heart disease, and cerebrovascular disorders.(9)

In this study, the main purpose was to assess the association between handgrip strength (HGS) and body mass index (BMI) of the patients having cardiovascular diseases (CVD). Body mass index (BMI) is an easy and acceptable weight-category screening measure that is closely linked to health status. The association between body mass index and handgrip strength has been widely established. Some studies revealed positive association between HGS and BMI as Shamsul Azhar Shah, et all revealed through their study (21) but some of them showed negative relation between them as Dhananjaya J R, et all (10) and Luigi Barrea, et all showed through their study.(22) Furthermore, in some studies, it is shown that BMI and HGS has no significant relationship. Agnieszka Wiśniowska-Szurlej, et all showed through their study that BMI and HGS had no significant association.(23) Similarly, Abdalla Alrashdan, et all (24) and Ukachukwu Okoroafor Abaraogu, et all (25) concluded that there was no relation between these variables.

In the current study, BMI and HGS were significantly negatively correlated. Pearson's correlation showed that BMI and HGS of both hands of the patients had negative and statistically significant association. This result was similar to the previous study conducted by Luigi Barrea, et all, in which these two variables had been evaluated, which concluded that BMI had a negative relationship with handgrip strength.(22) One more study conducted by Dhananjaya J R and his co-workers showed the same results as this current study did i.e BMI and HGS had a negative relation between them.(10)

This result was opposite to some previous studies. The present study's results were contrary to the study done by Shamsul Azhar Shah, et all which concluded that BMI and HGS had significant and positive association. (21) Similarly, Mateus Augusto Bim, et all conducted a study through which they showed that BMI and HGS had a positive relation in both males and females.(26) the current study's results were also contrary to one other study which was conducted by Chung Reen Kim, et all which concluded that participants with low HGS had lower BMI compared to those in the normal HGS group.(27)

If the grip status is seen according to the different categories of the BMI, the result of the current study showed that the participants of overweight category have strong grip strength and the participants of underweight category have lesser grip strength, confirming the previous study done by Eun-Jung Bae, et all that revealed that that a lesser handgrip strength was linked to being in the BMI category of underweight, whereas a stronger handgrip strength was linked to being overweight.(28) One more study, conducted by Park, Kyue-nam, showed the similar results, that when compared to the overweight and non-obese categories, the obese category had remarkably weak grip strength, as the current study did.(29) This outcome was contrary to the one previous study done by Juliana Paula BRUCH, et all which concluded that those who were overweight or obese had weak HGS than those who were of a healthy weight.(30)

Gender and age are the two main factors that influence handgrip strength, while gender accounting for the majority of the total variation.(11) Association of age and HGS of dominant and non-dominant hand had also been evaluated in this study. The outcome of the current study revealed that age and HGS were also significantly correlated in a

negative manner, confirming the previous studies done by Shamsul Azhar Shah, et all (21), Agnieszka Wiśniowska-Szurlej, et

all (23), Hirokazu Inoue, et all (31) and Xuemei Lu, et all (32) that revealed strong, negative and statistically significant relation between age and HGS. On the other hand, current study's result about age was contrary to the previous study conducted by Luigi Barrea, et all that showed no evident correlation between HGS and age.(22) Similarly, T.H.Musa, et all conducted a study, whom results were contrary to the current study's result, showed that HGS grew with age.(33)

Gender has a great impact on the HGS. Males have a better grip strength on average than females.7 In the present study, males had strong grip strength as compared to the females, confirming the previous studies done by Abdalla Alrashdan, et all (24), Hirokazu Inoue, et all (31), Xuemei Lu, et all (32), Xabier Río, et all (34) and Ukachukwu Okoroafor Abaraogu, et all (25) whom results were similar to the current study's results. The current study also concluded that the grip strength of dominant hand was stronger than the non-dominant hand, confirming the previous study done by Luciana Zaccagni, Stefania Toselli, et all which concluded that the HGS of the dominant hand was noticeably higher than that of the non-dominant hand in both sexes.(8)

Some limitations came up during this study, firstly this study is of cross sectional design due to which it is not clearly identified that whether low grip strength is the consequence of a cardiovascular disease or it is related to being obese and underweight. Secondly, the duration of disease was verbally notified by the patients and is not accurately mentioned. In addition, some other factors such as waist circumference, waist to hip ratio, hand dimensions and smoking status were not evaluated, which have significant impact on the hand grip strength.

More research with experimental or longitudinal study method is needed to deeply investigate the reasons behind the low hand grip strength. In this study, types of CVD were not in equal proportion so it is recommended that each type should have equal cases so the effect of disease may clearly be identified. Awareness on healthy lifestyle to decrease the chances of CVD and obesity is needed and this subject matter requires the attention of public health experts of our country.

The findings of this study revealed that the hand grip strength (HGS) and body mass index (BMI) had a statistically significant and negative association. Most of the participants whose HGS was normal belong to the overweight category and the participants with the lowest HGS belong to the underweight category of BMI. HGS also showed a negative and statistically significant association with the age of the patients and the duration of the cardiovascular diseases the patients had. Gender had a great impact on the hand grip strength.

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