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RESEARCH ARTICLE

Handgrip dynamometry in elderly individuals and its relation with body mass index

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ABSTRACT

Background: Increasing age and excessive amount of adipose tissue leads to a decrease in muscle mass and muscle strength, termed as sarcopenic obesity. Assessment of handgrip strength and body mass index (BMI) are two easy tests, which can provide information about total body strength in relation to BMI. **Aims and Objectives:** The aim of this study was to estimate the handgrip strength in urban elderly individuals of Amritsar and correlates it with BMI. **Materials and Methods:** The present cross-sectional study was conducted on 173 elderly male and female participants, who were divided further into three subgroups each according to their age, i.e., Group A (50-59 years), Group B (60-69 years), and Group C (70 years and above). The handgrip strength for both dominant and non-dominant hands was measured using simple spring-type handgrip dynamometer. Three anthropometric variables, i.e., height, weight, and BMI were recorded. The data were analyzed statistically. **Results:** Grip strength decreased significantly with age in both males and females. Males were stronger than females in all the age groups. Correlation studies showed a significant inverse relationship existed between handgrip strength and BMI. The increase in BMI led to a decrease in handgrip strength in both males and females. **Conclusion:** From our study, we can conclude that age-related decline in handgrip strength occurs from 50 years onward, in both males and females. An increase in BMI led to a decrease in handgrip strength. This information can be helpful in future studies, using grip strength as a measure of physical strength in elderly Punjabis.

KEY WORDS: Handgrip Strength; Body Mass Index; Elderly Males and Females

INTRODUCTION

It is well established that aging is associated with a significant decline in muscle strength. Age-related strength losses are mainly secondary to decline in skeletal muscle mass in men and women. While women may experience earlier strength losses than men, overall, age-associated decreases in strength are similar when controlling for muscle mass.[1] Assessing handgrip strength is an easy test that can provide an approximation of total body muscle strength.[2] Muscle mass and strength decrease with age leading to sarcopenia, which is associated with impaired functioning. Potential causal factors include age-related declines in anabolic steroid hormones and growth factors, decreased muscle protein synthesis, nervous system degeneration, as well as the pathological effects of poor nutrition, physical inactivity, and chronic disease.[3]

Grip strength was moderately correlated with overall body strength in the very old and oldest populations.[4] Many of the research studies correlated grip strength to various other

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physical variables including nutritional status, rotator cuff weakness, fatigue, and overall physical function.[5]

Nutritional status has also been correlated to handgrip strength. The findings draw parallel to the findings of the anthropometric measurement studies. One's nutritional status will lead to specific levels of body mass, which, in turn, has been found to correlate directly to grip strength. This simple method of non-invasive measurement may provide nutritionists and medical professionals with valuable screening data before further more invasive testing.[6,7]

Age-related loss of muscle mass is accompanied by fat gain in older adults.[8-10] Therefore, fat mass may play a role in age-adipose tissue.[11,12] A recent study showed that older obese persons with low muscle strength have a particularly high risk of a decline in walking speed and risk of developing mobility limitation.[13]

The predisposing influence of a sedentary lifestyle on age-related cardiometabolic diseases (i.e., obesity, Type 2 diabetes mellitus, hypertension, and coronary artery disease) is well established. Evidence of the protective effects of physical activity against certain cancers falls and mental health problems is accumulating.[14] The findings have substantial implications for care of a growing elderly population. Application of handgrip dynamometry as a screening tool in a multidimensional geriatric assessment may help identify older people at risk for disability and holds potential for use in prognostication of survival among elderly people.[15]

Handgrip strength is an estimate of isometric strength in the upper extremity but also correlates with strength in other muscle groups,[8] and therefore, has been taken as an estimate of "overall strength." Old age is associated with inevitable time-dependent losses in physical capabilities. However, falling levels of customary physical activity are suspected to contribute substantially to these losses as well as deterioration in physical and mental health.[16]

Handgrip strength is a physiological variable that is affected by a number of factors including age, gender, and body size.[17] To establish a relationship between the said parameters in this part of the country, the present study has been undertaken.

MATERIALS AND METHODS

The present cross-sectional study was conducted on males and females of age 50 years and above, selected from the general population of Amritsar. The study was conducted on 173 participants and took about 7 months to complete. The participants were divided into 3 major groups depending on their age: Group-A (50-59 years), Group-B (60-69 years), and Group-C (70 years and above). A complete physical examination was done. Participants with history of trauma in the hand or wrist or prior surgery on upper limb were excluded from the study. Participants suffering from shoulder pain or any joint pains were excluded from the study. All participants were informed about the procedure, and a written consent was taken. Approval for the study was taken by the College Ethical Committee.

Three anthropometric variables, i.e., height, weight, and body mass index (BMI) were taken. BMI was recorded using Quetelet's formula (BMI = weight [kg]/height [cm]^2).[18] Current weight was measured to the nearest 100 g and standing height to the nearest 0.5 cm, with participants wearing light clothing and no shoes. Handgrip strength for both the hands (dominant as well as non-dominant) was recorded. Obesity was defined as BMI >30 kg/m^2.

Handgrip Strength Assessment Test

The grip strength of both dominant and non-dominant hands was measured using a simple spring-type handgrip dynamometer in standing position with shoulder adducted and neutrally rotated and elbow in full extension. Hand dominance was determined by asking the participant to throw a tennis ball. The data were collected under natural environmental conditions in the morning between 7 a.m and 9 a.m. The dynamometer was held freely without support, not touching the participant's trunk. The participant was asked to put maximum force on the dynamometer thrice with both the hands, separately. The value was recorded in kilograms. The best of three attempts were recorded. A 30 s interval was maintained between each of the handgrip testings.

Statistical Analysis

Data will be analyzed by one-way ANOVA test, Student's *t*-test, and Pearson's correlation and inferences drawn. SPSS 16 was used for analysis. The difference was considered significant if $P < 0.05$; and highly significant if $P < 0.001$.

RESULTS

As expected, men were stronger than women in all the age groups. Grip strength decreased with increasing age. Table 1 shows the mean values for handgrip strength in both dominants as well as non-dominant hand in male and female participants in three age groups. In the dominant hand, male participants in the age group of 50-59 years and 60-69 years, the mean handgrip strength in males was statistically highly significant than their female counterparts. In the age group of 70 years and above, the mean values for handgrip strength in males were more as compared to females of the same age group, but the difference was not statistically significant.

On the non-dominant side, the difference in mean values of handgrip strength in males and females of the age

Table 1: Mean values of handgrip strength in all the age groups

Age group (years)	Dominant side			Non-dominant Side		
	Male mean±SD	Female mean±SD	*P* value	Male mean±SD	Female mean±SD	*P* value
50-59	23.27±3.89[a]	19.69±1.91[a]	<0.001**	18.80±2.46[a]	12.44±3.16[a]	<0.001**
60-69	20.30±2.34[b]	16.83±2.93[bc]	<0.001**	15.43±2.66[b]	13.10±2.43[a]	0.006*
70 and above	15.64±2.73[c]	14.36±2.44[c]	0.724[NS]	11.16±1.81[c]	10.96±1.62[a]	0.998[NS]

NS: *P*>0.05; Not significant, **P*<0.05; Significant; ***P*<0.001; Highly significant. Mean values with different alphabets are statistically significant when compared inter-age group

group 50-59 years was highly significant, whereas this difference in the age group of 60-69 years was significant, and in the age group of 70 years and above, it was not significant. The Table 1 also shows that the mean values of handgrip strength were statistically significant when compared between the two subgroups in each of the subgroups as shown by superscripted alphabets along the mean values.

Table 2 shows mean BMI values for males and females in all the age groups. Correlation between the mean values of BMI and handgrip strength in all the groups (Table 3) showed that on the dominant side; the Pearson's correlation coefficient (*r*-value) in the age group of 50-59 years in males was −0.577 (*P* = 0.001, significant), and in females, it was −0.830 (*P* < 0.001, highly significant). In the age group of 60-69 years, in males, *r*-value was −0.825 (*P* < 0.001, highly significant), and in females, it was −0.890 (*P* < 0.001, highly significant). In the age group of 70 and above, in males, *r*-value was −0.709 (*P* < 0.001, highly significant), and in females, it was −0.719 (*P* = 0.004, significant). On the non-dominant side, the Pearson's correlation coefficient (*r*-value) in the age group of 50-59 years was −0.623 (*P* < 0.001, highly significant), and in females, it was −0.257 (*P* = 0.156, not significant). In the age group of 60-69 years, *r*-value in males was −0.586 (*P* = 0.001, significant), and in females, it was −0.482 (*P* = 0.008, significant). Whereas in the age group of 70 and above, no significant correlation could be drawn in both males and females (*r* = −0.339 and 0.344).

No significant results could be drawn for both handgrip strength and its correlation with BMI in elderly participants (both males and females) in the age group >70 years.

DISCUSSION

Measurement of grip strength has been included in many aging studies. Furthermore, grip strength has proved to be a strong predictor of phenotypes of special interest among the elderly, e.g., physical functioning and disability,[19-21] morbidity,[22,23] and mortality.[24-27]

An age-related reduction of muscle mass and strength is a major public health concern in older persons because of its important role in the causal pathway leading to functional limitations, increased risk of falls, disability, and mortality.[24]

Table 2: Mean values of BMI in all the groups

Age group (years)	(BMI) kg/m²	
	Males	Females
50-59	25.59±2.73	26.79±4.84
60-69	26.11±2.71	28.11±4.73
70 and above	30.48±3.25	27.37±4.04

Table 3: Correlation of BMI with handgrip strength

Age group (years)	Dominant side		Non-dominant side	
	Male	Female	Male	Female
50-59	*r*=−0.577 *P*=0.001*	*r*=−0.830 *P*<0.001**	*r*=−0.623 *P*<0.001**	*r*=−0.257 *P*=0.156
60-69	*r*=−0.825 *P*<0.001**	*r*=−0.890 *P*<0.001**	*r*=−0.586 *P*=0.001*	*r*=−0.482 *P*=0.008*
70 and above	*r*=−0.709 *P*<0.001**	*r*=−0.719 *P*=0.004*	*r*=−0.339 *P*=0.077	*r*=0.344 *P*=0.229

r: Pearson correlation coefficient of BMI with handgrip strength; **P*<0.05; Significant; ***P*<0.001; Highly significant

The findings in our study also depict similar findings. The handgrip strength decreased with increasing age in both males and females, in dominant as well as non-dominant hand.

In our study groups, correlation studies between handgrip strength and BMI have shown a significant correlation in males as well as females in all the age groups, in dominant hand. In non-dominant hand, a significant correlation could be drawn in both males and females in 50-59 years and 60-69 years group only. This is supported by the fact that there are age-related changes in body composition, particularly increases in fat and central fat deposition and decrease in lean mass, which may result in low skeletal muscle mass and obesity (sarcopenic obesity). Therefore, one can have a high BMI with weak muscle strength due to sarcopenic obesity.[28]

Age-related loss of muscle mass is accompanied by fat gain in older adults.[8-10] Excess adiposity depresses anabolic action of insulin in stimulating protein synthesis,[29] which may contribute to progressive loss of muscle mass, strength, and quality. In addition to its function in energy storage, fat tissue also secretes many adipocytokines such as interleukin-6, tumor necrosis factor-α, and leptin[30] that may have a catabolic effect on muscle, thus decreasing muscle mass and strength.[31-34] Long-term exposure to

obesity is associated with poor handgrip strength later in life. Maintaining healthy body weight throughout the life span may help to maintain adequate muscle strength in old age.[35] Older men and men with higher BMI at baseline (who also had higher initial grip strength) are also more likely to experience steeper declines in handgrip strength.[36] Physical inactivity is related to fatness and low lean mass and muscle strength.

The estimation of handgrip strength is of immense importance in determining the efficacy of different treatment strategies of the hand and also in hand rehabilitation. Grip strength determines the handedness of an individual, an important field of population variation study. It is often used as an indicator of overall physical strength.[37,38] Handgrip strength is a physiological variable that is affected by a number of factors including age, gender, and body size.[17]

Given its predictive validity and simplicity, dynamometrically measured grip strength should be considered as a vital sign useful for screening middle-aged and older adults.[39]

A few limitations of the present study require consideration. Our study included only small number of participants which may not represent true elderly population. Second, we did not evaluate factors such as hand size, upper arm circumference, occupation, lifestyle, medications, and mental status measures which can affect the handgrip strength. Physical activity scores need to be measured with the help various scales available. Inactivity along with increased prevalence of medical comorbidities and physical disability increase with age. Lack of exercise is itself a risk factor for sarcopenia.

CONCLUSION

From the present study, we can conclude that the age-associated decline in grip strength occurs from 50 years and onward. We also found in elderly individuals without a known history of upper extremity disorder or surgery; grip strength is inversely related to BMI in both men and women; an increase in BMI led to decrease in grip strength in both males and females. Grip strength is an inexpensive and an easy to measure test and is associated with current and future physical functioning, morbidity, and mortality.

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