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Original article

Influence of various anthropometric parameters on handgrip strength and endurance in young males and females

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ABSTRACT

Background & objectives: Handgrip strength (HGS) is an important test to evaluate physical fitness and nutritional status. It is a physiological variable that is affected by a number of factors including age, gender, body size, posture etc. The aim of the present study was to assess the gender differences and also assess the correlation between handgrip strength and endurance and various anthropometric parameters in young males and females. Method: The study included 200 apparently healthy subjects (100 males and 100 females) of the age group 20 to 30 years. Anthropometric parameters like weight, height and Body mass index (BMI) were recorded and subjects were classified into 3 groups as underweight BMI $\leq$ 18.5 kg/ m^2 (30 each), normal weight BMI 18.5 - 24.9 kg/ m_2 (40 each) and overweight BMI $\geq$25kg/m^2 (30 each). Handgrip strength and endurance was recorded using handgrip dynamometer. Gender wise difference was analyzed by unpaired't' test. Correlation between handgrip strength and endurance and various anthropometric parameters was assessed by calculating Pearson's correlation coefficient. Results: We found that handgrip strength and endurance was significantly higher in males compared to females ($p<0.05$). Significant negative correlation was found between handgrip strength and weight in overweight males ($p<0.05$) and significant positive correlation between handgrip endurance and weight and BMI only in underweight males ($p<0.05$). Conclusion: Our observations indicate that there are gender differences in correlation between handgrip strength and endurance and various anthropometric parameters indicating that there may be several factors besides anthropometric parameters which influence handgrip strength and endurance. Though our study was not vast, it does provide a glimpse of the gender differences and influence of various anthropometric parameters on handgrip strength and endurance in young males and females.

1.Introduction:

Handgrip strength (HGS) is an important test to evaluate physical fitness and nutritional status. It has come to be regarded as the most reliable clinical measure of human strength. Hand grip strength is a physiological variable that is affected by a number of factors including age, gender, body size and posture etc. The power of hand grip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal bio kinetic conditions [1]. Endurance of the muscle refers to its capacity to withstand the power produced during activity. In other words, Handgrip endurance (HGE) is ability to sustain a muscular force. The ability is significantly correlated with the strength of a brief maximum effort [2]. HGS also varies as a function of developmental factors including nutrition, exercise, and health [3]. Muscle strength may be impaired in obese persons, and this impairment may be a consequence of both obesity and low physical fitness [4]. Poor muscle strength has also been found to be associated with lower body weight and poor nutritional status is associated with poor HGS [5]. However at all levels of body weight, there is a wide variability in strength.

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Strength is related to age and sex. At all ages girls have lower average values than boys and after puberty this difference increases, until by the age of 18years boys have a mean handgrip 60% higher than girls. Men possess considerably greater strength than women for all muscle groups tested. Women score about 50% lower than men for upper body strength and about 30% less for leg strength [6].

Many hand-grip strength studies with healthy adults have shown that anthropometric variables such as height, weight, body mass index, hand length, and hand width are positively associated with grip strength [7,8] and also it was found that the dominant hand had approximately 10% stronger grip strength than the non dominant hand [9]. There is good evidence that HGS is a strong indicator of health status, based on the incidence of disability, morbidity, and mortality in adult populations [10] .

There is little data available on the influence of gender and various anthropometric parameters like weight , height and BMI on handgrip strength and endurance especially in young males and females of the age 20 to 30years in Davangere city, hence the present study was planned with the following objectives.

1. To assess the gender differences in handgrip strength and endurance in young males and females.

2. To assess the correlation between various anthropometric parameters and handgrip strength and endurance in young males and females

2. Materials and Method

200 apparently healthy subjects (100 males and 100 females) of the age group 20 to 30 years were selected randomly from the general population of Davangere city. The study was conducted in Department of Physiology, J.J.M.Medical College, Davangere after obtaining informed and written consent from the subjects. Ethical clearance was obtained from Institutional Ethical Clearance Committee. Subjects included did not have history of Diabetes mellitus, Hypertension, other cardiovascular diseases, surgery, chronic medication, any muscular disorder, hand pain or arthritis. The study was conducted 2-3 hours after a light breakfast. Height was measured to the nearest 0.5 cm with wall mounted scale and weight measured to the nearest 0.5 kg using a beam balance scale in light indoor clothing. Body mass index (BMI) was calculated by Quetelet's index, BMI = Weight (kg)/Height $(m)^2$. Subjects were classified into three groups based on the BMI values as follows:

Underweight (UW) (BMI $\leq$ 18.5 kg/m^2)

Normal weight (NW) (BMI 18.5 - 24.9 kg/m^2)

Overweight (OW) (BMI $\geq$25 kg/m^2)

A minimum of 30 subjects were taken in each BMI group for better analysis.

Handgrip strength (HGS) was determined using a handgrip dynamometer (INCO) as the maximal voluntary contraction (kg)

sustained for at least 3 seconds. Each subject was given verbal instructions and demonstration before being tested and further instructions were provided at the time of the test. Subject stood upright holding the dynamometer in the dominant hand, with the shoulder abducted and elbow in full extension and was encouraged to exert the maximal grip. Three trials with brief pauses of 10-20 seconds were allowed and best result was chosen for analysis.

Handgrip endurance (HGE) was determined by asking the subject to maintain 1/3 of maximal voluntary contraction for as long as he/she could. For this test, subject was made to sit with forearm placed on a table, flexed at 90^0 and was asked to maintain a grip 1/3 of maximal voluntary contraction and the time in seconds (sec) was noted. This eliminated weight bearing of the instrument during prolonged contraction.

The data was analysed by using SPSS version 17.Gender wise difference was analyzed by unpaired't' test. Correlation between handgrip strength and endurance and various anthropometric parameters was assessed by calculating Pearson's correlation coefficient. Descriptive data are presented as mean$\pm$standard deviation. Results were considered to be significant if their associated p values were less than 0.05.

3. Results

Comparisons between males and females:

Table 1 reveals that handgrip strength and endurance was significantly higher in males compared to females ($p<0.05$). When comparison was made between males and females with similar nutritional status, it was found that males had high handgrip strength (Table 2) and endurance (Table 3) than females in each group ($p<0.05$).

Correlations:

There was significant positive correlation between handgrip strength and weight and BMI only in females ($p<0.05$) (Table 4) and significant positive correlation between handgrip endurance and all the anthropometric parameters (weight, height &BMI) only in males. ($p<0.05$)(Table 5)

Correlations within each group:

Significant negative correlation was found between handgrip strength and weight in overweight males ($p<0.05$) (Table 6) and significant positive correlation between handgrip endurance and weight and BMI only in underweight males. ($p<0.05$)(Table7).

TABLE 1: Mean values and standard deviations of various parameters in males and females of aged 20-30 years. Data are expressed as mean + standard deviation.

Parameters	Males	Females	t -value	Sig.(2-tailed)
Weight (kg)	60.63 ±12.46	53.27 ± 11.77	4.29	0.000
Height (m)	1.67±0.05	1.5 5± 0.06	13.82	0.000
BMI (kg/m_2)	21.63±4.01	22.06 ± 4.32	-0.72	0.473
Handgrip strength (kg)	28.9±5.84	19.4 ± 4.8	12.53	0.000
Handgrip endurance (sec)	72.04±22.8	44.43± 23.1	8.49	0.000

P value < 0.05 significant

Table 2: Comparison of handgrip strength (kg) in different weight groups in males and females. Data are expressed as mean ± standard deviation.

Weight group	Males	Females	t -value	Sig.(2-tailed)
Underweight	25.7 ± 4.7	16.6 ± 4.03	8.02	0.000
Normal weight	31.25 ± 5.65	20.27± 4.53	9.57	0.000
Overweight	29.06 ± 5.75	21.1± 4.95	5.75	0.000

P value < 0.05 significant

Table 3: Comparison of handgrip endurance (seconds) in different weight groups in males and females. Data are expressed as mean ± standard deviation

Weight group	Males	Females	t -value	Sig.(2-tailed)
Underweight	59.23 ± 17.11	39.33± 25.82	3.518	0.001
Normal weight	78.15 ± 25.4	46.1 ± 24.09	5.78	0.000
Overweight	76.7 ± 19.1	47.3 ± 18.4	6.05	0.000

P value < 0.05 significant

Table 4: Correlation between handgrip strength (HGS) and various parameters in males and females. Data are expressed as Pearson's correlation coefficient.

Correlation between HGS and	Males		Females	
	r value	P value	R value	r value
Weight	0.126	0.212	0.402*	0.000
Height	0.045	0.654	0.156	0.121
BMI	0.128	0.205	0.386*	0.000
Handgrip endurance	0.592*	0.000	0.294*	0.003

*Correlation is significant at the 0.05level (2-tailed)

Table5: Correlation between handgrip endurance (HGE) and various anthropometric parameters in males and females. Data are expressed as Pearson's correlation coefficient.

Correlation between HGS and	Males		Females	
	r value	P value	R value	r value
Weight	0.266*	0.008	0.063	0.536
Height	0.216*	0.031	-0.01	0.922
BMI	0.222*	0.026	0.078	0.443

*Correlation is significant at the 0.05level (2-tailed)

Table6: Correlation between handgrip strength and various anthropometric parameters in different weight groups in males and females. Data are expressed as Pearson's correlation coefficient.

Weight group	Weight		Height		BMI	
	r value	P value	r value	P Value	r value	P Value
Underweight males	0.232	0.218	0.088	0.654	0.272	0.147
Normal weight males	0.173	0.286	0.280	0.08	-0.028	0.86
Overweight males	-0.365	0.047*	-0.349	0.059	-0.124	0.512
Underweight females	0.139	0.465	0.156	0.41	0.000	1.000
Normal weight females	0.358	0.023	0.203	0.208	0.200	0.217
Overweight females	0.246	0.19	0.121	0.523	0.290	0.120

***Correlation is significant at the 0.05level (2-tailed)**

Table7: Correlation between handgrip endurance and various anthropometric parameters in different weight groups in males and females. Data are expressed as Pearson's correlation coefficient.

Weight group	Weight		Height		BMI	
	r value	P value	r value	P value	r value	P value
Underweight males	0.42	0.021*	0.221	0.24	0.376	0.04*
Normal weight males	0.09	0.546	0.286	0.073	-0.055	0.734
Overweight males	-0.069	0.717	0.009	0.916	-0.119	0.532
Underweight females	0.142	0.454	0.146	0.441	0.012	0.948
Normal weight females	0.113	0.486	0.179	0.269	-0.063	0.701
Overweight females	0.219	0.245	0.227	0.228	0.159	0.401

***Correlation is significant at the 0.05level (2-tailed)**

4. Discussion

The results from this study showed significant difference in handgrip strength and endurance between males and females with males having high grip strength and endurance than females. Muscle strength is determined largely by muscle girth; a muscle with a larger cross-sectional area can generate more force and therefore lift more weight than one with a smaller cross sectional area. Because the male hormone testosterone enlarges muscles, men tend to be stronger than women [2]. This gender disparity is independent of the measuring device. The greater muscle strength in males has been to a large extent attributed to differences in musclemass [11]. Also it was found that testosterone increases type II fibres [12] which are the fast fibres with high activity of glycolytic enzymes and a higher proportion of type II fibres in males would thus be consistent with our findings of greater muscle strength in males.

Similar findings were reported by previous studies [4,13,14].

In our study we found significant negative correlation between handgrip strength and weight in overweight males. The impairment of muscle strength in obese and overweight persons may be a consequence of both obesity and low physical fitness. Physical activity hindered the accumulation of body fat and extensive use of the hands and finger muscles during physical activity enables to achieve greater strength [15].

The probable reason for significant positive correlation between handgrip endurance and weight and BMI only in underweight males could be that in underweight male subjects, fat mass is very less and thus it is not difficult to appreciate the positive correlation between body mass index and hand grip strength and endurance [13].

Although, there are statistically significant correlations between handgrip strength and endurance in different groups among males and females in our study, it is likely that several factors besides anthropometric parameters also influence handgrip strength and endurance like grip span [16] and hand span [17].

5. Conclusions

HGS is a powerful predictor of health and vitality in both men and women. In the present study we found that males had significantly higher handgrip strength and endurance than females, significant positive correlation between handgrip strength and weight and BMI only in females and significant positive correlation between handgrip endurance and all the anthropometric parameters (weight, height &BMI) only in males. Thus, there are also gender differences in correlation between handgrip strength and endurance and various anthropometric parameters indicating that there may be several factors besides anthropometric parameters which influence handgrip strength and endurance.

Though our study was not vast, it does provide a glimpse of the gender differences and influence of various anthropometric parameters on handgrip strength and endurance in young males and females

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