ORIGINAL ARTICLE

CORRELATION BETWEEN BODY MASS INDEX AND HANDGRIP STRENGTH AND HANDGRIP ENDURANCE AMONG YOUNG HEALTHY ADULTS

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ABSTRACT: BACKGROUND: Physical inactivity has become a serious problem all over the world. Handgrip Strength (a form of isometric static contraction test), is an important test to evaluate the physical fitness and nutritional status of an individual. A number of factors like age, gender, body size, effort, skeletal muscle bulk and contractility may affect the handgrip strength (HGS) and handgrip endurance (HGE). **AIM:** This study was conducted to establish the possible correlation (if any) between body mass index and handgrip strength and endurance among young healthy adults. **MATERIALS AND METHODS:** A population based cross-sectional study comprising of 200 students (both male and female), age group-18-22 yrs was carried out in the Department of Physiology, Jorhat Medical College. Anthropometric parameters like height and weight were taken to evaluate the BMI and handgrip strength and handgrip endurance were taken by using handgrip dynamometer. According to WHO classification of BMI, subjects were categorized into three groups as underweight BMI ≤18.5 kg/m^2, normal weight BMI 18.5-24.9 kg/m^2 and overweight BMI≥ 24.9 kg/m^2. Gender wise difference was analyzed by unpaired t test. Statistical analysis for correlation was done by using Karl Pearson's Correlation Coefficient denoted by(r). **RESULT:** Males had higher handgrip strength and handgrip endurance than females. Statistically significant correlation was found between BMI and handgrip strength & endurance in underweight & overweight subjects. Gender differences in correlation were observed in correlation between BMI & HGS and HGE. **CONCLUSION:** The observed influence of BMI and gender differences in correlation between BMI and HGS and HGE indicate that besides BMI several other factors like effort, strength, muscular contractility etc. affect muscular strength & endurance in young males and females.

KEYWORDS: BMI, Handgrip strength, Handgrip endurance.

INTRODUCTION: Today's world is greatly facing the epidemic of cardiovascular disorders which is a consequence of overweight or obesity, sedentary lifestyle and low physical fitness. About 1/4th of world's population do not meet the recommended levels of moderate physical activity and do not engage in any leisure time physical activity at all.

HGS, a form of isometric (static contraction) test is a reliable clinical measure to assess the physical fitness and nutritional status of an individual. It is the most common assessment method to measure the upper extremity muscle strength.(1) Muscle strength is impaired in overweight/obese persons and this impairment may be a consequence of both obesity and low physical fitness. Poor muscle strength is also found to be associated with low body weight and poor nutritional status. HGS is a good indicator of health status based on the incidence of

disability, morbidity, and mortality in adult population.[2] The power of handgrip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal biokinetic conditions.[3] Handgrip strength, a physiological variable, is affected by a number of factors like age, gender, body size, effort, skeletal muscle bulk and contractility.[4]

Handgrip endurance (HGE) is the ability of a muscle to sustain a muscular force produced during activity. It is significantly correlated with the strength of a brief maximum effort. Endurance, to a great extent depends on the nutritive support for the muscle.[5] It is also affected by factors like cardiorespiratory fitness, skeletal muscle function, blood flow and temperature of the muscle.

Strength is related to age and sex.[6] At all ages girls have lower average values than boys and after puberty this difference increases, until by the age of 18 yrs boys have a mean handgrip 60% higher than girls.[7] Males possess considerably greater strength than females for all muscle groups tested.[8,9] Many handgrip strength studies in young healthy adults have revealed that anthropometric variables like height, weight, BMI, hand length, hand width, grip span, are positively associated with handgrip strength.[10,4]

Various studies were carried out to assess the cardiovascular component of physical fitness but very few studies were done to assess the muscular strength and endurance component of physical fitness, so the present was planned to observe the influence of gender and BMI on handgrip strength and endurance in young males and females of age group 18-22 years in Jorhat city with the following objectives.

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

To assess the correlation (if any) between BMI and handgrip strength and endurance in young male and females.

MATERIALS AND METHODS: This study is a cross-sectional based study, comprising of 200 subjects, both male and female, belonging to age group 18-23 years. It was carried out in the Dept. of Physiology after obtaining informed and written consent from the subjects. The study population was selected after taking a detailed history and observing the exclusion criteria that included history of intake of any drugs and history or clinical evidence of any medical illnesses. The study was conducted after keeping the subject at physical rest for at least 10 mins. Height was measured to the nearest centimeter with an anthropometer and weight was measured to the nearest kilogram with Krups flat type of weighing machine. BMI was then calculated by using Quetlet index. According to WHO classification of BMI, subjects were then categorized into three groups as underweight BMI ≤18.5 kg/m^2, normal weight BMI 18.5-24.9 kg/m^2 and overweight BMI≥ 24.9 kg/m^2.

$$BMI = \frac{\text{weight (kg)}}{\text{height}^2\ (m^2)}$$

Handgrip strength (HGS) was determined by using a handgrip dynamometer (INCO, ambala) as the maximal voluntary contraction (MVC in kg) sustained for atleast 3 secs. Prior to the test each subject was given verbal instruction and demonstration of the test. Subject stood upright by holding the dynamometer in dominant hand, with the shoulder abducted and elbow in full extension. Three readings with brief pauses of 10-20 seconds were taken and then the best result was chosen for analysis.

Handgrip endurance (HGE) was determined by asking the subject to sustain $1/3^{rd}$ of maximal voluntary contraction for as long as he/she could. Subject was made to sit with the forearm placed on a table, flexed at 90^0 and was asked to maintain a grip of $1/3^{rd}$ of MVC and then the time recording was noted in seconds.

Statistical analysis was done after obtaining the recordings. Gender wise difference was analyzed by unpaired `t' test. Correlation between BMI and handgrip strength and endurance was assessed by calculating Karl Pearson's Correlation Coefficient, denoted by `r'. After calculating the `r', the test of significance was checked by using the Correlation Coefficient table of Probability. Significant correlation is said to be present if the calculated value of `r' is greater than the table value i.e. $p<0.05$. Mean ± standard deviation was used to present the descriptive data.

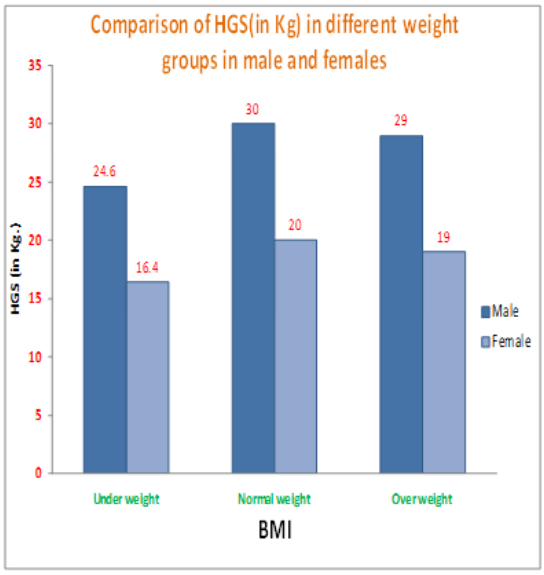
RESULTS: Statistical analysis of study population revealed that 61% of subjects belong to normal weight category (39% males and 31% females); 24% subjects belong to overweight category (28% males and 38% females) and 15% subjects belong to underweight category (33% males and 31% females). Thus a substantial proportion of subjects belong to overweight category.

Table 1 shows that males had significant higher handgrip strength and endurance compared to females ($p<0.05$). When comparison was made between male and female of similar nutritional status it was noted that males had higher handgrip strength (Fig. 1) and endurance (Fig. 2) than females.

Parameters	Males	Females	t-value	Significance
BMI (Kg/m^2)	20.5±4.02	22.01±3.02	-0.69	0.373
HGS (Kg)	27.5±4.09	20.07±4.5	13.41	0.000
HGE (sec)	80±23.01	45.01±20.07	9.49	0.001

Table 1: Mean±standard deviation values of BMI, HGS and HGE in males and females

P value < 0.05 significant.



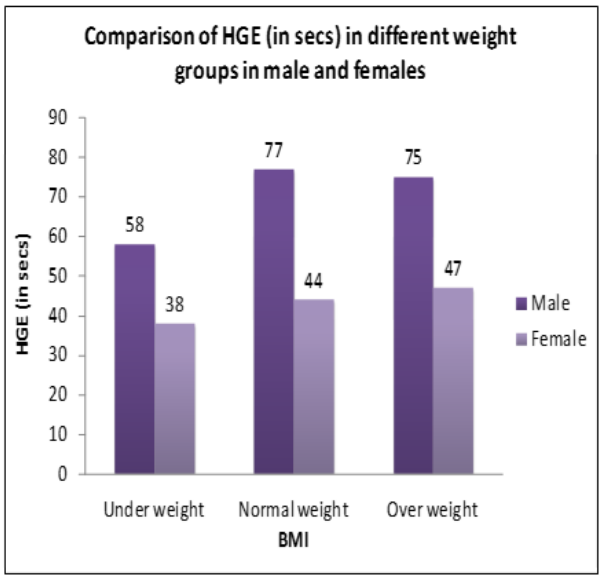


Figure 1 & 2

Table 2 shows statistically significant correlation between BMI and HGS in females ($p<0.05$) and significant correlation between BMI and HGE in males ($p<0.05$). When correlation was calculated among underweight, normal weight and overweight males and females it was observed that significant negative correlation is present between BMI and HGS in overweight females and significant positive correlation is present between BMI and HGE in underweight males and females table 3.

Correlation between BMI and	Males		Females	
	r value	P value	r value	P value
HGS	0.128	0.205	0.386 *	0.000
HGE	0.222 *	0.026	0.078	0.443

Table 2: Correlation between BMI and HGS and HGE in males and females Data are expressed as Pearson's correlation co-efficient

Correlation is significant at/<0.05 level.

Weight Group	HGS		HGE	
	r value	P value	r value	P value
Under-weight males	0.27	> 0.147	0.42	.021 *
Normal weight males	-0.028	0.86	0.06	0.734
Over weight males	0.123	0.512	-0.05	0.701
Under-weight females	0.000	1.000	0.376	0.04 *
Normal weight females	0.200	0.217	0.24	0.402
Over weight females	-0.346	0.047 *	-0.023	0.601

Table 3: Correlation between BMI and HGS and HGE in different weight groups in males and females Data are expressed as Pearson's correlation co-efficient

Correlation is significant at 0.05 level.

DISCUSSION: Analysis of study population revealed that majority of subjects belonged to overweight category, percentage being more in females than in males.[11,12] Moreover it was observed that males showed higher handgrip strength and handgrip endurance than females. This difference mainly attributes to difference in muscle mass, weight, arm muscle circumference and presence of testosterone in males. Similar findings were also observed in.[3,13,14]

Muscle strength is mainly determined by muscle size, with a maximum contractile force between 3 and 4 kg/m2 of muscle cross-sectional area.[15,16] As male hormone testosterone helps in increasing the muscle size, so men tends to be stronger than women.[17] It was also found that testosterone increases the type 2 fibres in muscle[18] which are fast type of fibres with high glycolytic activity. Thus increase amount of type 2 fibres in males contribute to increase muscle strength in them than in females which is consistent with our findings.

Statistically significant negative correlation between BMI and HGS was observed in overweight females. This impairment of muscle strength in obese and overweight females may be a consequence of both obesity and reduced physical fitness.

Moreover significant positive correlation has been observed between BMI and HGE in underweight males and females. In underweight subjects, fat mass is less and therefore it is easy to appreciate positive correlation between BMI and HGE.[14]

In our study, although we have found significant correlation between body mass index and handgrip strength and handgrip endurance in different weight groups among males and females, the presence of gender differences in correlation between BMI and HGS and HGE indicate that besides BMI, several other factors like grip span,[19] hand span,[20] body size, skeletal muscle bulk, arm and calf muscle circumference[7] strength, effort etc. influence handgrip strength and handgrip endurance.

CONCLUSION: Physical fitness is very much essential for maintaining a healthy life. Handgrip strength and endurance are important parameters to assess the upper extremity muscular strength of an individual. BMI is considered as an useful, commonly used tool to measure the degree of overweight. As there is very little data available on the influence of BMI and gender on handgrip strength and handgrip endurance in young healthy males and females in Jorhat city, so the present study was taken. The presence of correlation between BMI and HGS and HGE and the observed gender differences in correlation between them indicate that besides body mass index several other factors like effort, strength, muscular contractility, grip span, hand span etc. affect muscular strength & endurance in young males and females. To specify the particular cause of these differences more studies with greater number of representative samples are required.

REFERENCES:

1. Vespa J, Watson I. Who are the nutritionally vulnerable in Bosnia Hercegovnia? Br Med J 1995; 311: 652-654.
2. Giampaoli S,Ferrucci L, Cecchi F, Lo Noce C, Poce A, Dima F et al. Handgrip strength predicts incident disability in non-disabled older men. Age and Aging 1999; 28: 283-288.
3. Shyamal Koley Meenal Gandhi, Arvinder Pal Singh. An association of Handgrip strength with height, weight, and BMI in boys and girls aged 6-25 years of Amritsar, Punjab, India. The Internet Journal of Biological Anthropology.2008; 2(1).
4. Vaz M, Hunsberger S, Diffey B.Prediction equations for handgrip strength in healthy male and female subjects encompassing a wide age range. Ann Hum Biol. 2002; 29: 131-141.
5. Edwards RH, Young A, Hosking GP, Jones DA. Human skeletal muscle function: description of tests and normal values. Clin Sci Mol Med 1977; 52: 283-90.
6. Agnew PJ, Mass F. Hand function related to age and sex. Arch Phys Med Rehabil 1982; 63: 269-71.
7. Richards L and Palmiter- Thomas. Grip strength measurements. A critical review of tools, methods and clinical utility. Critical Reviews in Physical and Rehabilitation on Medicine 1996; 8: 87-109.
8. Heyword, VH (1986).Gender differences in strength. Research Quarterly in Exercise and Sport. 1986: 154-9.
9. Hanten WP et al. Maximum grip strength in normal subjects from 20-64 years of age. J Hand Ther 1999; 12: 193-200.
10. Chatterjee S and Chowdhuri BJ (1991) Comparison of grip strength and isometric endurance between the right and left hands of men and their relationship with age and other physical parameters. J. Hum. Ergol.20 (1): 41-50.
11. WP Jia et al. Study on obesity and its comorbidities in Urban Chinese older than 20 years of age in Shenghai, China. Obesity Reviews 2002; 3: 157-162.
12. Shamail Zafar et al. Relationship of body mass index and waist to hip ratio measurement with hypertension in young medical students. Pak J Med Sc. 2007; 23: 4.

13. Smrithi Shetty C, Shibin Girish Parkanandy, Nagaraja S. Influence of various anthropometric parameters on handgrip strength and handgrip endurance in young males and females. Int J Biol Med Res.2012; 3(3): 2153-2157.
14. Ravisankar P, Madanmohan, Udupa K, Prakash ES. Correlation between Body Mass Index and Blood Pressure indices, Handgrip strength and Handgrip endurance in underweight, normal and overweight adolescents. Indian J Physiol Pharmacol 2005; 49(4): 455-461.
15. Guyton and Hall Textbook of Medical Physiology 9th edition 1996.
16. Maughan RJ. Relationship between muscle strength and muscle cross sectional area. Implications for training. Sports Med 1984; 1: 263-9. Am J Clin Nutr 1982; 36: 680?
17. Morehouse LE, Miller AT, Strength In: Physiology of exercise.5th edition London:The CV Mosby Company; 1967: p 50-60.
18. Gutman E, Hanzlikova V, Lojda Z. Effect of androgens on histochemical fibre type. Differentiation in temporal muscle of guinea pig. Histochemie 1970; 24(4): 455-61.
19. Watanabe T, Owashi K, Kanauchi Y, Mura N, Ogino T. The short term reliability of grip strength measurement and the effects of posture and grip span. J Hand Surg2005; 30A: 603 609.
20. Ruiz JR, Espana-Romero V et al. Hand span influences optimal grip span in male and female teenagers. J Hand Surg 2006; 31 A: 1367-1372.

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